

Quartz roofing
slates

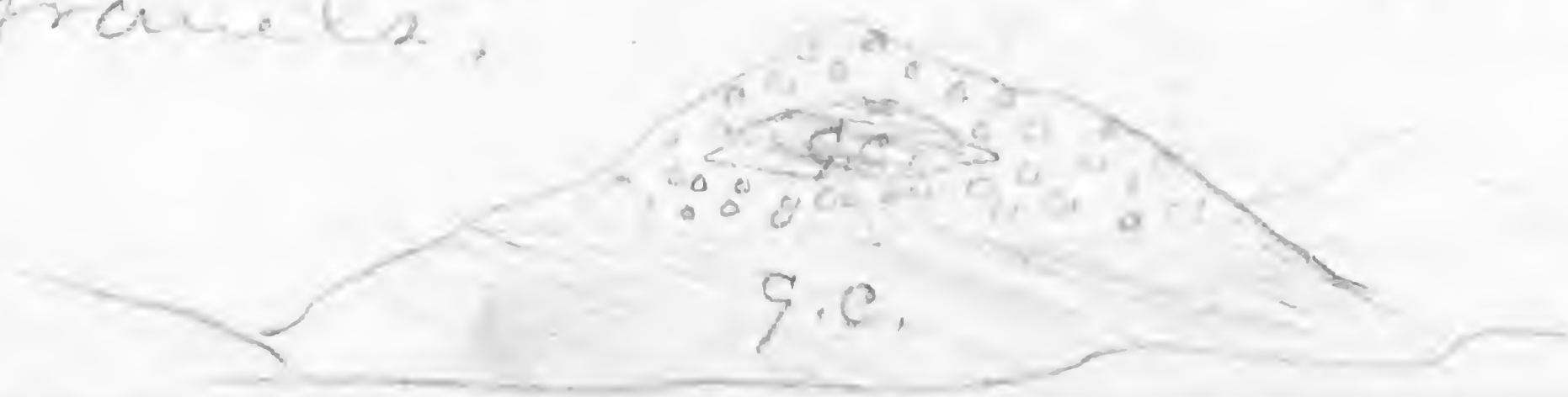
Arvon -
Buckingham Co
Va

Dec. 18/82.

The accumulation of dirt, gravel & boulders on the slopes & in the lower portion of the upper canyons of Mu-Hong, Ma-gut & Chuan valleys are frequently of considerable extent & cover the underlying rocks except where a steep slope or the cutting down of the canyon beds exposes them. Where, however, as is the case in Chuan valley, the hills have long been separated from the source of the debris, i.e. the higher canyon walls & cliffs, erosion has gradually removed all this covering & left the clays & harder layers of the G. C. group in full view. There is evidence in all these valleys of a period when the drainage into the Colorado was at a higher level, during which time ^{an} immense accumulation of debris occurred. The lowering of the Colorado permitted the lowering of the stream a canyon beds & debris

channels were cut down thro' the masses of debris. Along the banks of the Colorado a similar deposit, much like many of the Quaternary deposits of New York state & the eastern side of the continent, shows that the river was dammed & backed up so as to fill in the channel 2 or 3 hundred feet. The debris of the valleys shows well for the last. Red wall & Aubrey while that of the Colorado is much more composite in character owing to the varied sources of the material but dam by the river.

In Cheon valley water occurs a bed of gravel etc. having been deposited & over this a mass of the clays etc. of the grand canyon etc. have shifted from above & again the gravel etc. has covered over it. Subsequent erosion has cut away the slope & left a point with the interbedded gravels.



Dec. 18/82

Section in Chuan Valley. Chuan 24.
From drainage line (Stream) north. Midway of Valley.

(1)
1.
2.

1. Compact lead colored l- 2 ft.

2. Friable rather coarse gray to buff sd. 5-8

3. Gray l-in layers. 1 ft 2-6. (with a tendency to break up in shaly layers - separated by thin layers of clay shale drab + black. Layer of concretionary l- 3 in near base. Looks like some Stromatopora form.

5-8

5-8

4. Dark clay shale

4-

5. " Shaly l-

1-

1-

6. Drab clay shale

4-4
22-

7. The succession of clay shale + limestone with a few alternating beds of sandstone continues on up 500 feet when the l- layers become less + sandstone more abundant. No good line of demarcation can be drawn. In the 500 feet of beds 5 ft 6 in of l- occurs as measured by rule. Section by level.

500-

54-6

8. To this is added ~~775~~ ⁶²⁵ feet of clay + sandy shales with sandstone in narrow bands. The shales are usually chocolate brown, greenish or yellowish green. A few limestone layers near the base + middle of the 29 feet of limestone.

625
~~775~~ 1142
~~1142~~

21.
84-2

The strike + dip of the beds is given on the map.

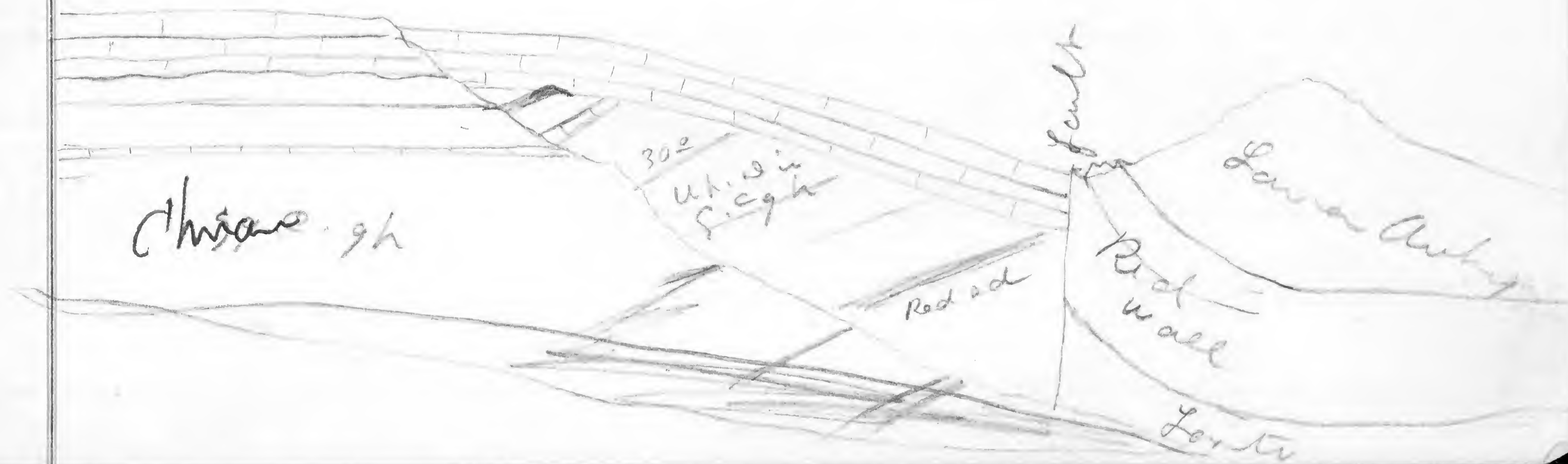


		Best Land.	1147 1297	84-2
	7 ^c	shaly dark gray ls in massive layers.	2 ft	
	2	dark clay shale	6 "	
	3	shaly dark gray l - "	3 "	
0/	4	<u>Stromatopora</u> limestone contains fine specimens of this or a closely allied genus	4 "	
	5	Alternating clay & sandy shales with layers of limestone.		
		limestone 29 shales 28 1/2	310 289 -	+ 325. 29 -
				<u>113 - 2</u>
	8-	Chocolate & dark clay shales with bands of brown & greenish sandy shales alternating from 5 to to 25 feet & passing above into a brown sandy shale		200
S				
a	8a	A band of <u>Calitic</u> iron ore 2 feet thick occurs near the summit & traces of what appear to have been fossils.		
f			300,	
	8 ^a	massive layer of reddish brown sandstone interrupted in places by shaly sd.	25.	<u>1772</u>
	8 ^b	thin bedded sd. with clay shale & a massive layer of sd. at summit	55.	<u>1852</u>
	8 ^c	Sandy & clay shale, chocolate	40.	
	9	massive stratum carbonate limestone. 4 to 6 feet		

Ripple
marks
" "

The section continues on up thru several hundred feet of 3
the clays of the upper **Chuan**, but a synclinal axis
and fault breaks it up & the red sandstone is a strongly
marked boundary of the ^{summit of the} middle division of the
group. The fault line ^{in the} **Chuan** runs along the south
side of the ridge bounding Chuan valley on the north
& drops the clays of the upper division of the
Chuan 500 feet. The Lata rests conformably
upon them on the west end of the exposure &
towards the divide (?) the ~~l.c.~~ beds dip westward.
The canon valley north of Chuan is sur-
rounded by the Lata with the **Chuan**, in sides
& bottom to where it narrows to pass into
the canon leading to the river. In the lower
portion of the valley the massive red sandstone

after the base of the upper div - *Chuan* g. crasses with
 a N + S. strike & a westerly dip of 30° to 40° , disappear-
 ing under the Lente on each side N + S. In the
 clays above, this dip rapidly disappears & the
 red sd - capping *Shen-Ho* - weak butte & the upper
 div - *C. g. h.* passes beneath the Lente as the
 conformable in deposition ^{see back of page} & traces of erosion having
 given the base of the Lente a slightly undulating
 line, N. side of Canton valley.



Just as it comes out at the end of a parish it is level
 But on a cliff back further north it is seen to
 turn up as shown in the sketch. A closer view shows
 that its upturned edge formed a ridge & that the
 Tertiary was deposited over it.



The next two canons north ^{N.W.} show the crossing of the red sd. (laver) + some of the clay shales above & below but debris covers the slopes & the exposure before the Lante is quite limited.

Dec. 22^d 1882.

Collecting lithological specimens & looking for fossils in the argillaceous shales of the ^{laver} ~~middle~~ division of the Chad — 9 p.m. did not discover any.

The upper division of the Chad is from the summit of New-Komech butte to the massive red sandstone below. The ~~lower~~ div. is from that

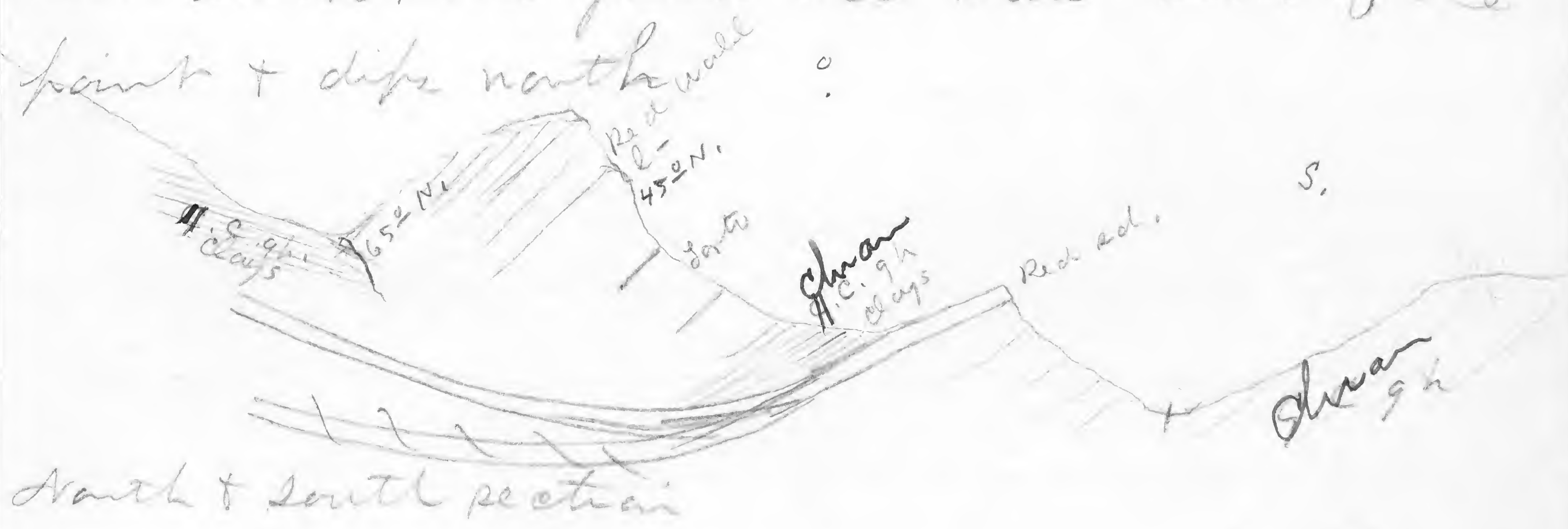
down to the great sandstone series.
 The upper div - is characterized by
 the great development of clays, & the
~~layers~~ by its clays ^{shales} & interbedded lime-
 stones. ~~& the lower by its sandstones.~~

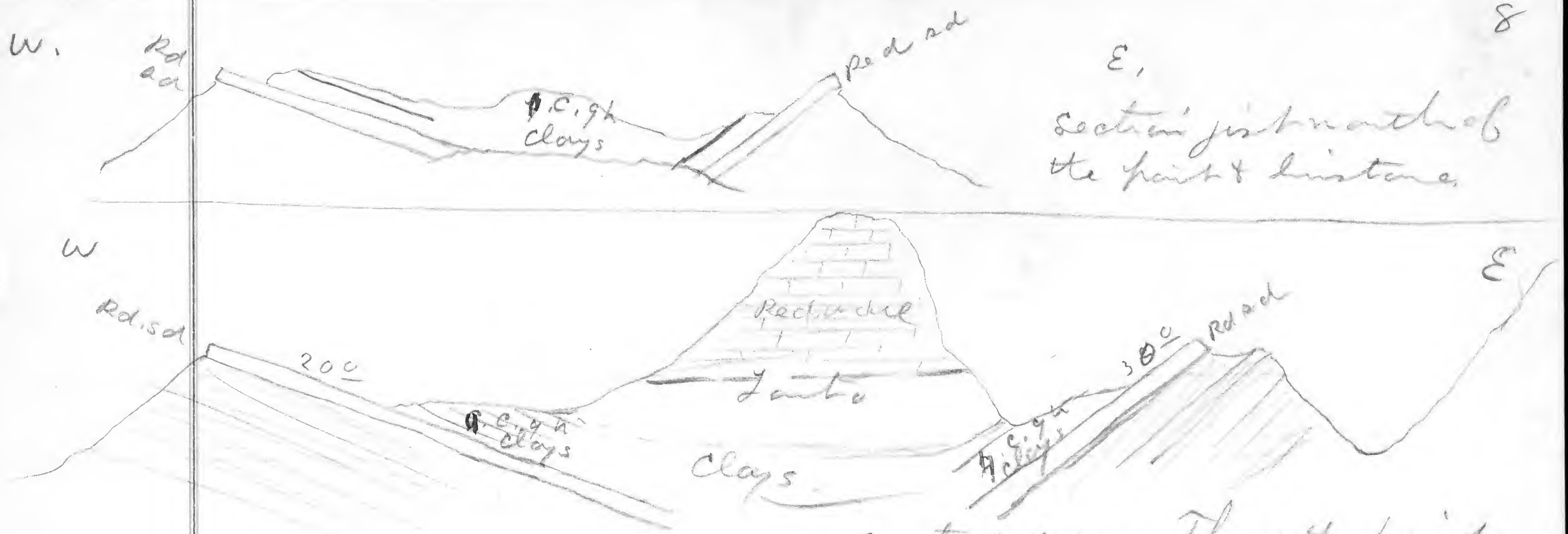
Dec. 23rd.

SS. subsidence by erosion
 In the A.E. side of Chuan valley, a point rises
 which is cut off from the north wall of the valley
 by a ~~deep~~ saddle & to the south a steep slope of 500
 feet or more brings it out in strong relief. All
 around its E. S. & W. base the massive red s.d.,
 capping the ~~lower~~ division of the ~~Chuan~~ dips
 in towards it leaving it in the center of a bowl
 like depression. Over the red s.d., the clays

the harder strata of the Chuan G.C. gh., dip in towards the point, where suddenly the massive sds., of the Lower Lonto gh., appear dipping north, these continue up about 200 feet when the limestones of the Upper Lonto show thro' the debris & soon the base of the Red wall l- is met with. This forms the main mass of the point & dips north.

Lonto cliff.
G.C. gh





Particular attention is given this point as it is an illustration of the effects of erosion & underlining of a harder formation & letting it down by ^{by the} degrees until from this cause alone ^{the shape of the point} they are ^{are} dropped 1000 feet from their normal position in relation to the surrounding strata. During all this the ^{mass} has retained its bedding & the northward dip of from 35° to 65° is the only evidence

of its having been undisturbed & dropped little by little to its present position. The Butte[#] fault line is $\frac{1}{2}$ mile to the east & the Limestone & Late of the point have evidently been lowered since the erosion of Chuan valley began.

[#] I call this the butte fault line as it has its inception on the north at the foot of the butte at the mouth of Hun-Ko-weah valley & extends along the west side of the six great buttes separating the valleys of Hun-Ko-weah Kwang-ut & Chuan from the Calanado Cañon proper & terminates on the south at the foot of the great south butte on the east of Chuan valley. It is not the true



Kai-bob fault, altho contemporaneous with the
 " " uplift + fold but rather the line of
 fracture ^{along} which the ~~Chuan~~ ^{Chuan} group was
 forced up & from the stratum of the ~~Chuan~~ ^{Chuan} g.p., along
 this line, beneath the Lento, it would appear
 that there was a line of less resistance in
 pre-Lento times (as in the time when the
 present faulting occurred (but the fault).

Pre-Lento land surface.

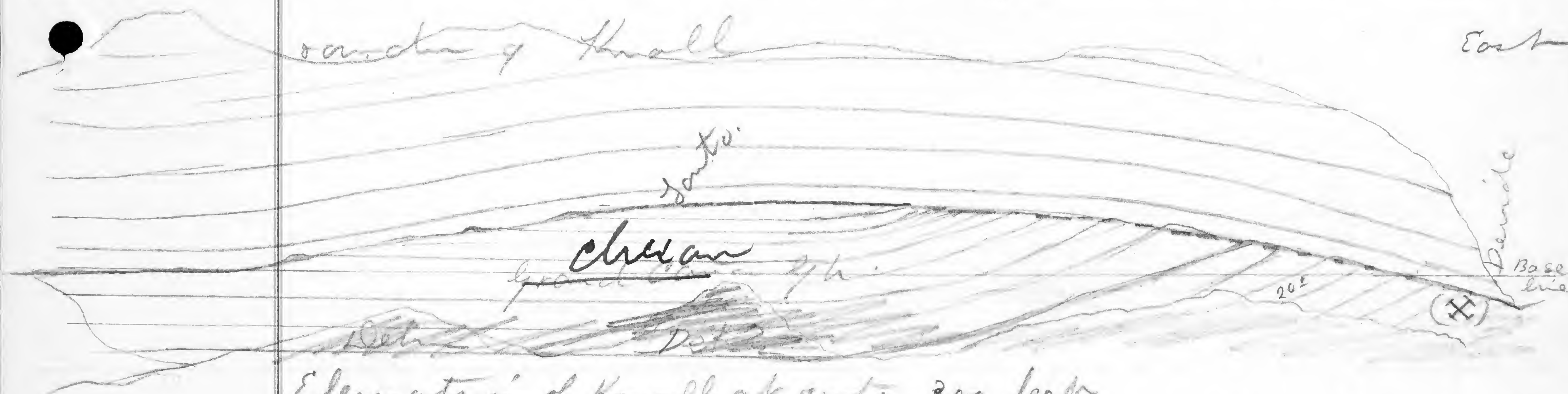
On the north^E side of Chuan valley the Lento
 curves gently down towards the Butte fault
 line. I had supposed this to be a part of
 the Kai-bob fold but a close examination
 of the underlying beds shows ~~that~~

(At least) a
 very distinct
 section
 See fault

nest

no evidence of such a disturbance or fold
but that the Lento is deposited over an
~~existing~~ small

East-



Elevation of Knoll at center 300 feet.
The beds at (X) show a little crushing but this is but
a little distance from the fault line (but the fault).

Dec. 24th, Merry Christmas

12

" 25th, Went up one of the large N.C. canyons at the head of Chuan valley. After a dangerous climb reached the top of the Lanto & collected a few fossils. The shales & limestone of the lower half of the middle division of the ~~Grand Canyon~~ ^{Chuan} G.C. underlie the Lanto with a dip of 1°. This & the slight erosion of these beds is the only evidence of the unconformity. Nothing else of importance noted.

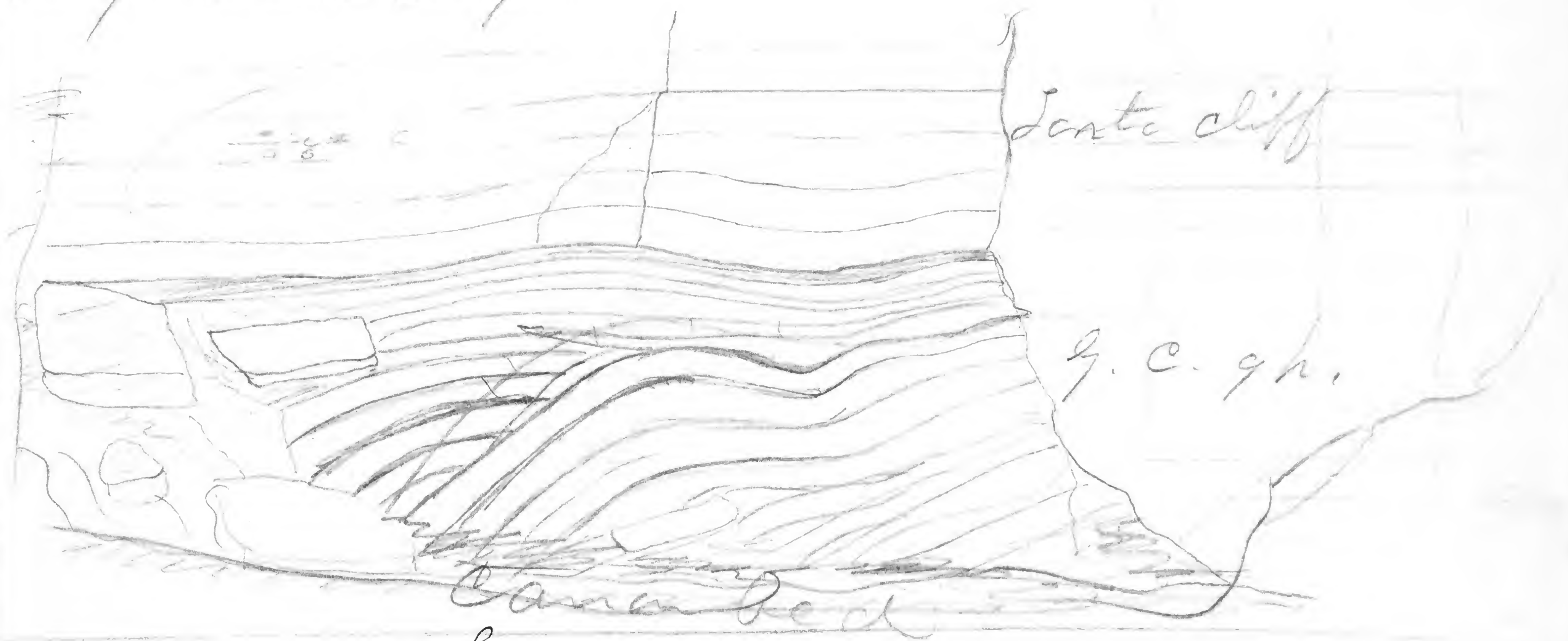
Dec. 26th

At the mouth of the north canyon draining Chuan valley into the Colorado. The base of the Lanto is 250 feet above the river & is underlain conformably by the upper strata of the ~~lower~~ ^{division} of the G.C. g.p. Reddish sd. with interbedded shaly bands. argt & areaceous.

The lower Lanto sd. presents its characters & thickness as also the upper members of the group.

The conformity between the Lanto & G.C. g.p.s


continues up the narrow cañon leading to (13).
 Chuar valley for some distance when
 signs of unconformity begin to appear, one of
 which shows the flexing of the G.C. g.h. beds
 very distinctly.



Butte fault line.

The cañon begins at the line of the Butte fault
 line & the Lento sandstone beds are turned
 up. Solid layers 18" in thickness coming out.

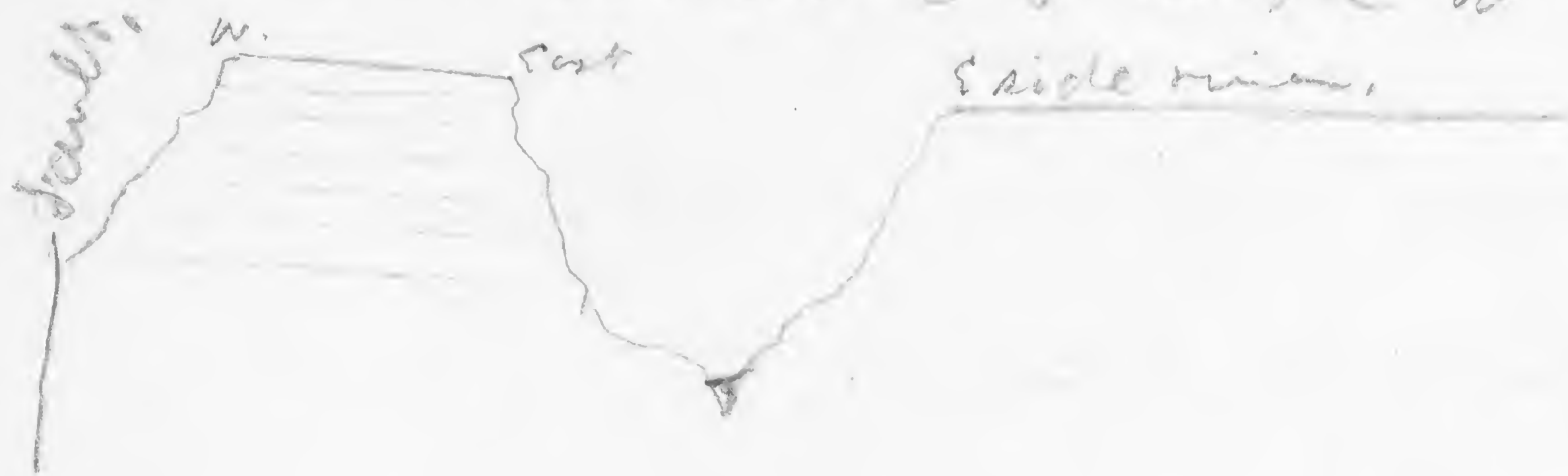


fracture. a little on the south the g.c. beds are seen turned up in the opposite direction  G.C. Beds.

Dec. 29/82. ^{GS} (In the lower cherty beds of the Red Wall I noticed numerous specimens of Levestella, Productus semireticulatus, Athyris subtilita. (mostly in the condition of casts in the chert.)

^{Leavenworth}
Beds of a similar character to those on the south side of Chuan valley occur on the north side on the most easterly spur. No fossils are here of uncertainty so doubt them being the same. The summit of this point is about 100 feet above the level of the Plateau at the mouth of the little Colorado, and those of the high butte rise about 300 feet above the ^{level}

line of the ~~east cliff~~ summit of the ~~east~~ cliff of the Colorado
on their west side & slope to about 150 feet on their east side.



Dec. 27"

Addition to section ~~Chuan~~ ^{Chuan} already written in Chuan valley. Starting below & going up to base of other section. Notes p. 1

15
Limestone

1. Massive band of irregular, thinly bedded limestone, gray & buff except near the summit where a chocolate tint prevails. This belt includes a variety of ~~layers~~ limestone
- a. Layers of hard compact gray l. with dark calcification - little spots -
 - b. Very irregular calcification many l.
 - c. Thin shaly layers.
 - d. Evenly bedded thin layers of hard dead colored l.
 - e. White, chocolate color

50, 50 ft.

2. ~~1.~~ Chocolate col. sd. shale 15.
- b. " " passing into drab col. clay shale 40.
 - c. Ar + clay shales with interbedded thin layers of buff & choc. sd. terminating above in several thick layers of sd. 8 to 18 in. Ripple marks. Mud cracks. 55 110.
- 3.
- a. Greenish argillaceous shale 30 30
 - b. Brown sandstone in shaly & thin layers 20 20
 - c. Yellowish green & chocolate argillaceous & arenaceous shale 195 195

Brak band -

- d. ^{green, maroon, drab} Chocolate, Calcareous argillaceous shales with layers of thin bedded brownish sandstone 405 16
50 ft
- e. Black & brown argillaceous shale with interbedded more or less friable sandstone in thin layers. 95 180.
- f. Compact, lead colored limestone. 8 ft
- g. Six feet of shale, a layer of limestone like that of f. 5 feet of shale & another layer of lb. 11. feet. & then a series of black & chocolate colored argillaceous & arenaceous shales succeed. 180 16 ft
- h. Compact, mottled, buff colored limestone 3. feet interbedded in 12 feet of brown sandy shale 15 3 ft
- i. Chocolate & greenish colored argillaceous & arenaceous shale with harder layers of thin bedded sandstone & seams & patches of white gypsum in some localities in the valley. 100 975 ft 55 ft 4 in
- Black shale near
gully
- Next succeeds the limestones & shales of the section taken

See back.

In appearance the black shales are similar to those
higher in the section. Thin bands ^{2 1/2 to 6 in} of green, yellow
drab & shades of brown are interbedded all thro' the
lower portions of the this section. All the colored
shales weather out in stronger tints than when
in the beds & the black shales bleach to a dirty gray
except when iron is present when they turn to a ^{dark} rust
or yellowish color.

Chuan Valley

17

The strata of this section with that above to the massive red sandstone from the low surrounding hills of the central portion of Chuan valley. A few faults of from 1 to 50 feet throw scarcely break the continuity of the outcrops edges of the harder layers of limestone & sandstone as they sweep around from the S.W. to the east side of the valley with the Carboniferous but the strata rests in the center of the synclinal as they ^{point} ~~turn~~ ~~which they turn~~. The synclinal broadening out to the south, S.W. & S.E. from that ~~point~~. Any hard stratum may be followed for miles as its line of outcrop comes in & out around the hills & in the

shallow ^{depression} ~~running~~ between. Scarcely
 or bush of any size grows on these hills &
 all ~~foreign material~~ debris from the higher
 cliffs of the Luto & Cambrian has been removed
 leaving the shales & harder rocks almost
 entirely ~~exposed~~. a little ^{low} ~~page~~ brush &
 bunch grass ^{spotting} the surface.

On the south side of the main drainage
 line or ~~canyon~~ also immediately beneath
 the Luto cliff at the west & N. end of
 the valley the slopes are covered with
 debris & the strata of the ^{Chuan} ~~Grand Canyon~~ ^{gh}
 appear only in the deep steep washes leading
 down throo the slopes.

~~About all this rises the~~ Added to this wonderful display of structure & stratification is the strong contrast of colors of the various beds of shale, limestone & sandstone. The deep dark red of the massive sandstone with its band of brownish red shales below, which are underlain by ^{2990 feet of} ~~the~~ variegated strata ~~for 2000 feet~~. Various shades of green, brown, yellow, drab, buff with the rich maroon & pearl tints of the lower beds.

This forms the lower basin of the valley & above all around to the north, south & west rises the buff ~~tinted~~ sometimes reddish tinted lower ^{sandstone} ~~cliff~~, forming a wall

separating the highly colored beds below from those above as the Lanto passes from dark to light green with a cap of deep red ^{stagnid} limestone which underlies the massive Red Wall limestone. Step by step or terrace by terrace the vermilion colored Aubrey sandstones with each terrace built out in relief by its dark covering of Pinon pine, leads up to the gray cliff of the Upper Aubrey limestone which shows a forest clad slope near the summit 3500 feet above the base of the Lanto.

Turning to the east two black, lava capped hills guard the lower end of the

valley & beyond rises the east wall of the Colorado cañon with its varied strata, 5000 feet above the river. Of the interesting fault between the main valley system of Mm - Ku - wech, Kna - gut & Chm - & the buttes standing between them & the Colorado a beautiful section is seen as also to the S. E. of the curvature of the Kainab fold beyond the ^{terminating} fault line.

For evidence of the results of erosion the view is scarcely to be surpassed as a geologic ^{study} & beautiful view of cliff cañon scenery it is the finest ~~by all~~ that has yet met my eye either in nature or description, pictorial or written.

Dec. 29th

22

From the north the view of Chuan valley is quite unlike that from the south. The ~~semi~~ crescent shaped line of hills show their crests & the long slopes centering towards the butte resting in the synclinal, comparatively few edges of the strata can be seen & the entire surface of hill & slopes has the monotonous brown tinge & the debris covered slopes of the southern side unite with the lava hills at the north of the valley to give the entire scene a somber appearance. Even the great buttes on the N.E. look dark & the cliffs of the canon wall & Kaibab Plateau are

largely in the shadow of the afternoon sun. It is the canyon but not in its holiday dress. Even in the mists and steam it is more impressive the awful.

9.91

Debris.

The debris accumulated when the drainage line was at a higher level & now cut thru by the stream ^{flashed} channels is very compact & stands in a solid cliff sometimes 100 feet in height & great boulders project out many feet from the wall. Sometimes a flat rock has prevented the wearing away of the material below & it caps a column standing out from the main mass of the cliff.

Lento graph.

N. side Charr valley

The section of the Lento above the lower massive sandstone has deeper richer shades of green below & the summit is a stronger reddish brown than about Nun-Ko-neap. There is also much less limestone at the summit about 25 feet & the purplish colored sandstone just beneath this is thickened with the reddish brown / gives 150 feet.

Dec. 30th

25.

Out on long ridge descending Chuan valley from the next canon south. The ridge is capped with the Lower Tonto & underlain by the ^{Chuan} ~~f.c.~~ g.h. The view of Chuan valley is more extended than the one previously described but the details of color are not as well defined owing to distance. The synclinal with southern expansion ^{the} ~~concentric~~ butte is more extensively shown as all the ^{covered by it} ~~areas~~ visible at a glance.

To the south both the topography & geology of the lower levels differs. As steep ledges of dark sandstone

replace the rounded panti-colored
 slopes & hills of Choon, * Kwa-gust^{to Mung-ke-meh} valleys.
 The Lonto sweeps around from canyon to
 canyon with its mural wall below &
~~sloping~~ ^{smooth or} terraced slope to the Red Wall
 limestone above. The thin siliceous
 formations not appearing as a distinct
 topographical feature from the upper
 stratum of the Lonto.

Collected some elegant specimens of a
 bilobed species of Cruziana in the middle
 division of the Lonto. Between the massive
 coarse s.d. below & the limestone above,

Jan'y. 17/
1883.

Algonkian fauna
Chesapeake

27

Looking for fossils in ~~Grand Cañon~~ gp. Only found in a dark bituminous limestone a few traces of vegetable matter. On many pieces of limestone fragments of arthin incrustation look like broken bits of smooth shells but no regular form could be traced. Costs of mud cracks are very varied & abundant on the surface of the limestone, arenaceous and argillaceous layers. The uniformity in thickness & character of the different layers along an outcrop of several miles is a striking feature of the stratigraphy of the group.

1/2/83

Section at base of Chuar group.[#]

28

Rests unconformably on massive beds of a rough
partially metamorphosed limestone on the S. E.
a side of Chuar valley. These ~~masses~~ form a
~~rougher~~ rugged dark slightly arching
hillside with the shales of the Chuar g h
dipping away from it on the north, N. W.
a & west. The unconformity between the shales
and limestone is strongly marked. The lime-
stone having been exposed to erosion prior
to the deposition of the shales.

[#] As there is a distinct group below this in the Grand
Canyon & this does not appear in the walls of the
Colorado Canyon. The group as exposed in Mu-He-
meah, Hua-gant & Chuar valleys is called the
Chuar group from Chuar valley where it is best exposed.

1/13/83

28^a

In a more favorable locality away from the area near the latter fault line the change between the massive limestone & the clays above is merely lithologic & no unconformity is observed. Further study to the south is necessary before the unconformity can be disproved & the instance given on the preceding page ascribed to the action of the latter fault in disturbing the strata ^{adjoining it}.

The limestone at the summit is ^a still gray & reddish in color & partially crystalline. A fine exposure of the contact of this limestone & the chert group shows

1/14/83

that there is no unconformity between 286
the two but from a careful study of the
massive limestone I think it should
be placed with the lower group.
The Chunghbeginning above it. There
is first at the base of the Chungh
about 3 inches of argillaceous shale
(at) then 6 inches of a hard compact
fine grained gray limestone quite
unlike that below & characteristic
of the Chungh group. 3 or 4 feet of shale
& another layer of similar limestone
& then on up to the massive band
of limestone shales continue. The
Clay shales

beds at the
 the base of the shales are of a greenish color
 then open out into drab. brown black &
 higher a deep chocolate band of about six
 feet is strongly ~~definite~~ ^{marked} in in the greenish
 & yellowish colored shales and a similar
~~colored~~ ^{band of} dark maroon occurs at the summit. Drab
~~greenish~~ yellowish green & dark or brownish black
 shales occur between. Considerable very fine
 sand occurs in thin layers scattered thro' the shales
 & thin layers. 650 feet.

1/5/82

From the level of the Colorado river to Chino
 valley where it narrows to pass thro' the lava
 buttes is 225 feet. Locks level & Barometer. The
 map gives these as 600.

1/5/83

Butte fault.

30

The butte fault turns to the south east between Lempire butte & the north lava butte at the foot of Chuan valley & crosses the Colorado & dips out a short distance up a cañon coming in from the southeast, the strata forming a monoclinial fold instead of breaking.

Pocahontas fault.

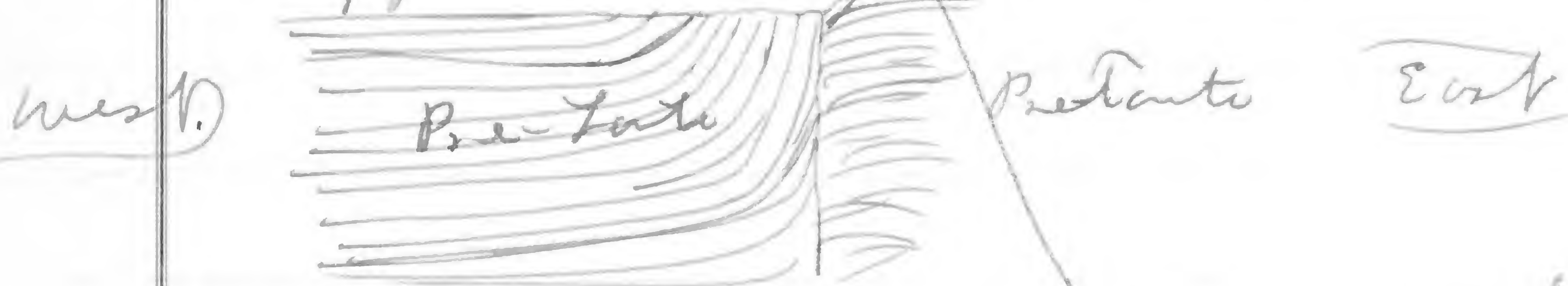
The old fault line during Pre-Late times ran along this line but it ^{also (or a branch)} continues on to the south crossing west of the lava butte of Chuan valley.

All along the butte fault the strata on each side turn up towards the fault



31
Pre-Tonto fault only to the east. This offers
to explain the peculiar character of the
little fault as seen in cross section.

The original Pre-Tonto fault had the
downthrow to the west & the beds
dragged on but up to the east.



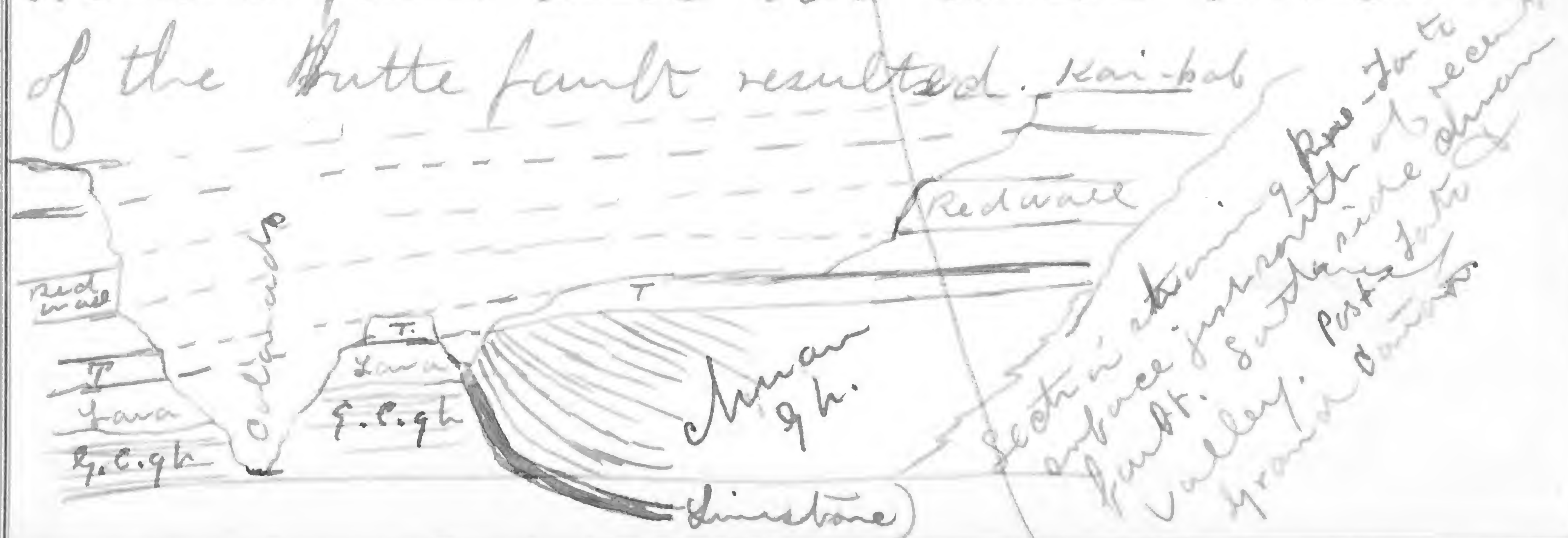
leaving the land surface in this ~~wise~~
at the time of the deposition of the Late
Surface for bento.



where the lava and sandstone on the 32
east side pushed up bending the more yielding
beds above to the west. ~~Over~~ The Pre-Tertiary
surface appears to have been planed off by
an advancing ocean line or there are no
canyons or other strong evidence of aerial
erosion the slight undulations of the surface
being scarcely perceptible at a moderate
distance. The Late & other Paleozoic groups
were then deposited with but little move-
ment along the ancient fault line, as also
the Mesozoic & probably Tertiary strata. When,
however, the Kai-las uplift manifested
itself a line of weakness already existed
in the Pre-Tertiary strata & along this line

the strata above gave way & a fault resulted³³
 the downthrow of which is about 2000 feet on
 the east. This broke the Pre-Tonto growth
 high on the eastern facing side of the
 fault so that subsequent erosion has laid
 it bare & also the strata above. The down-
 throw being to the east, the drag of the
 strata bent them up against the beds pre-
 viously bent up along the west side of the
 Pre-Tonto fault and the curious structure
 of the Butte fault resulted.

East



Lectra of north lava Butte.

34

Chinar Valley.

8^a

The summit has a few boulders of Lento sandstone showing a fragment of the original Lento cap ~~that~~ ^{sand & clay} rested on the chocolate brown ^{sand & clay} shales of the Grand Canyon g h. Of these there is 35 feet remaining. They dip N. 5°. Rippled

~~marked~~ & mud cracks occur.

8^J₁

These red rests on the surface of a dark gray, fine grained lava, which is quite uniform in texture except fillets of red & qtz in ~~cracks~~ or dikes. The lava has a greenish tinge below & is decomposed into a green anhydrous debris.

2³₃

2⁴

150 feet.

351

at the base of this bed there appears to be no marked lithologic change.

7^a

361

a parting between the upper flange bed & the next below is of a dark & chocolate color, evenly bedded & composed of 3 layers forming a band of 6 feet & below there is 2 feet of a shaly character when the summit of the next bed a flange is reached.

Flange no (2)

7

371

37^a

The summit is a brownish base with numerous (vesicular) cavities which are filled with quartz etc. in the solid unweathered portions. This extends down 50 feet & gives a variety of specimens

24 Lower down it becomes more solid
 + the lava compact like that in No 1.
 200 feet.

6a → a belt of unmetamorphosed reddish brown
 sandstone conformably overlies the next
 lava bed beneath which is much like
 the top bed. Then No 3. 35

6 → Compact ~~is~~ was gray colored beds.
 240 Breaks into angular fragments on the slopes.

5 This bed is quite uniform throughout except
 210 near the summit where it ~~is filled~~ with little round
 crystal filled cavities. 150.

24 On the north side of the butte these
 41 these beds are bent downward & mixed
 in with a volcanic breccia composed

212 of sandstone, lava & in places sand (3)
appears to be the matrix.

213 Fragments of green carb-copper occur
in association with this mass.

214 In veins running thro' the upper
flaw quartz crystals occur.

(Difficult to work this section owing to precipices.)

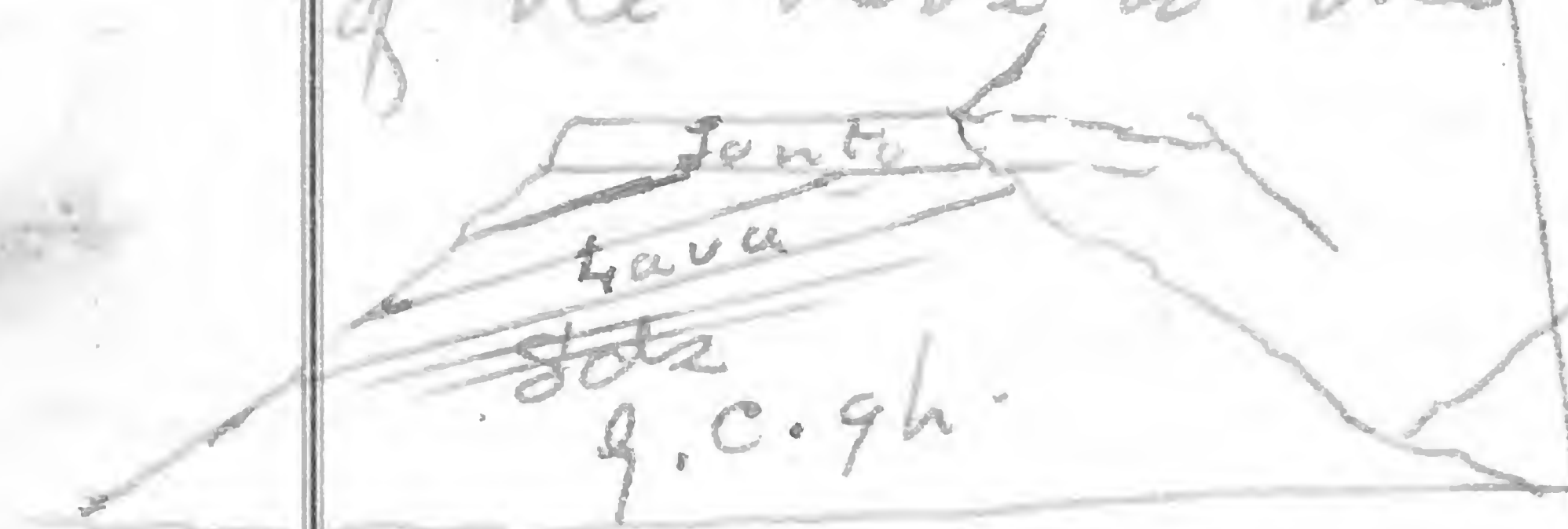
Continued on pg - 48 from base No 4
from Summit on pg. & pg. 55.

1/8/83.

38

Pre-Lento lava flows.

The top of the lava of the lava flow just mentioned (p. 34-37) crosses the river to the S.E. & is seen under the Lento cliff. The rise of the beds to the south can wedges it out

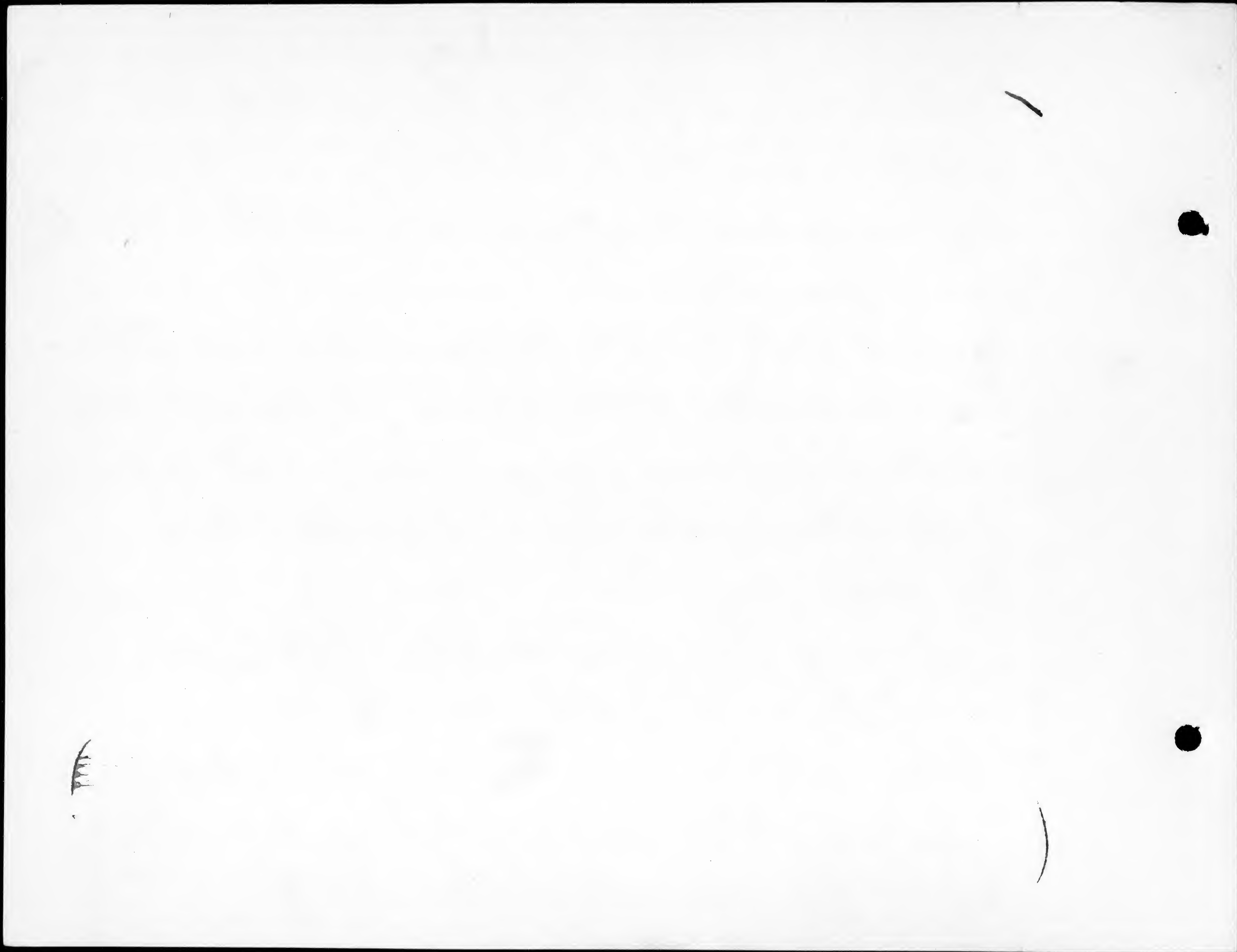


and it is not until the strata of the Grand Cañon gh. assume a horizontal position on a broad anticlinal axis that the lava ^{is seen} ~~appears~~ again. It appears with more or less persistence for two or three miles having a thickness of from 0 to 200 feet. The ^{Pre-}Lento surface is usual flared off nearly level but at one point an old hill hill remains rising 3 or 400 feet above

the average
surface. This is
the best example of
this yet observed.

Grand Canyon 9h.

On the west side of the river the Lark is
higher and the lava flows thicker. On
the south side of the south outlet of Chuan
valley the rise of the strata cuts out the
lava at the base of the Lark but a sharper
~~and~~ anticlinal than on the east side quickly
brings it in again with its entire thickness
as seen in the lava butte? In two instances
it appears as though canyons had existed prior
to the flow of the lava & been filled in. (a



Note will be added on this a further examination (20)

about 2 miles southwest of the mouth of Chum valley
a section from the Lantz dam gives 500 feet of
the variegated clay & arenaceous shales of the
Chum gp., above the massive belt of limestone

5) No. 6. of section (letter sheets) dip 50° N. This
is here 25 feet thick & of a more massive character
than in Chum valley. A characteristic
structure (?) almost Stratopora-like occurs in
the upper stratum.

Beneath there is about 400 feet of clay &
sandy shales as in the Chum section.

(These rest on an irregular reddish brown
limestone which was subjected to surface erosion
before the deposition of the shales.)

o) In character this is similar to that in the same 41
position in Chua valley. Thickness 200 feet.

Below reddish brown sds. evenly & thinly bedded
extend down 500 feet & rest on the lava
flow which may be traced continuously to
the lava butte of Chua valley.

Butte fault

The south
end of the butte fault line crosses south
from the west side of the lava butte of Chua
over a small divide separating the
Lento on the point south of the lava butte
from the main cliff & runs along
in an irregular line to nearly the
mouth of the first canon south of Chua
valley, where it finally terminates in
this direction (see sketch south of lava butte)

Along its line south of the lava butte
 it brings the lava up against the
 Chuan gh. and has, just where it
 passed beneath the Lanto on the divide
 leading from the river south into Chuan
 valley, a dam ^{at} there. (Pre-Lanto) of over
 1000 feet. & a little south of this it
 is about 1500 (probably nearly the same on
 the divide).

On the east side of the river the massive
 limestone belt is seen just above the lava to
 the westward. The limestone is between the
 h- & ad.

1/9/82.

Grand Canyon gp.

48

The lithologic character of this group
are quite uniform in the upper portion:
the strata consisting of redish brown and
greenish sandy shales & layers of a not
very fine sandstone varying from 2 in. to
3 feet in thickness. In the more thickly
bedded portions the resemblance to the
sandstones of the Trias (Vermillion cliffs)
is very striking. The shaly portions
also resemble the shaly beds of the same
formation. The prevailing color is
a redish brown much like that of
the lower Aubrey sandstone. Round
greenish spots from 1 in. to 5 in. in diameter

are scattered irregularly through the
layers of sandstone & shales.

Traces of organic life are as yet
unknown. Ripple marks, fine & coarse,
mud cracks on an extended scale &
all markings of shallow ~~and~~ water to which
shore exposed frequently to the water & air
abound. The characters of the growth
thus far corroborates the impression given
by the Chocoma group that a great
enclosed basin or mediterranean sea
existed in which the sediments were
deposited & there existed no commu-
nication by which the fauna of the older
Cambrian rocks of the eastern side

of the conditions under which they were deposited. Only by some such view can I account for the absence of a fauna in strata that were deposited under conditions ^{most} favorable to the development of a rich fauna ^{marine} flora (faunal). The fauna of the Lento above shows a connection with the later Cambrian of Nevada & also the Mississippi valley as shown in the Potsdam sandstone.

In going down the river the strata of the L. C. group are first seen a little distance above the north outlet of Chua valley. They lie conformably beneath the Lento cliff & appear to form a continuous

deposit with it. A mile south beyond ⁴⁶
the g. C. beds begin to rise at a rather
angle to the south and then the S. E.
branch of the better fault is crossed &
the Lento is seen capping a cliff
with the lava flows of the g. C. g.
& underlying strata unconformably
underlying it by a difference of dip
of 10° . The g. C. strata rise at a
dip of 5° to 10° for about half a mile
& then flatten out over a very broad
synclinal that extends with slight
undulations a mile or two down the
shores of the river. In places forming
cliffs but usually breaking down into

rounded slopes broken by outcropping (4)
edges of the harder sandstone. As
in the Chuan group area, the topography
& geology go hand in hand. The
latter directing the erosion & the
topography outlining the geology.

The ... of ... is ...
 ... of ... from ...
 ... on ... & ...
 ... in ... thickness.



South face of ...

... have been ...
 ... of the ...
 ... 10.5 ...

Colorado ...

1/14/83

Chua land pitte.

(5)

55

Flow No 5 from ~~the~~ the base appears to be a true flow altho resting on a thin stratum of sandstone and capped by another.

(33) 8 At the base it is very ^{tough} solid & compact breaking into angular fragments on exposure. Color greenish tinged with minute reddish spots particles grouped in an irregular manner.

(34) 9 Fifty feet from the base it is less compact & the reddish & green particles are quite evenly distributed. The former predominating. Towards the summit the reddish color forms the matrix & cavities of varying size 1 in to 1 cm in are filled with calcite? etc.,

(35) 2

The entire thickness is about 150 feet. Varies somewhat along its line of exposure. In most places presents a small space breaking off a little near the base.

h. 36

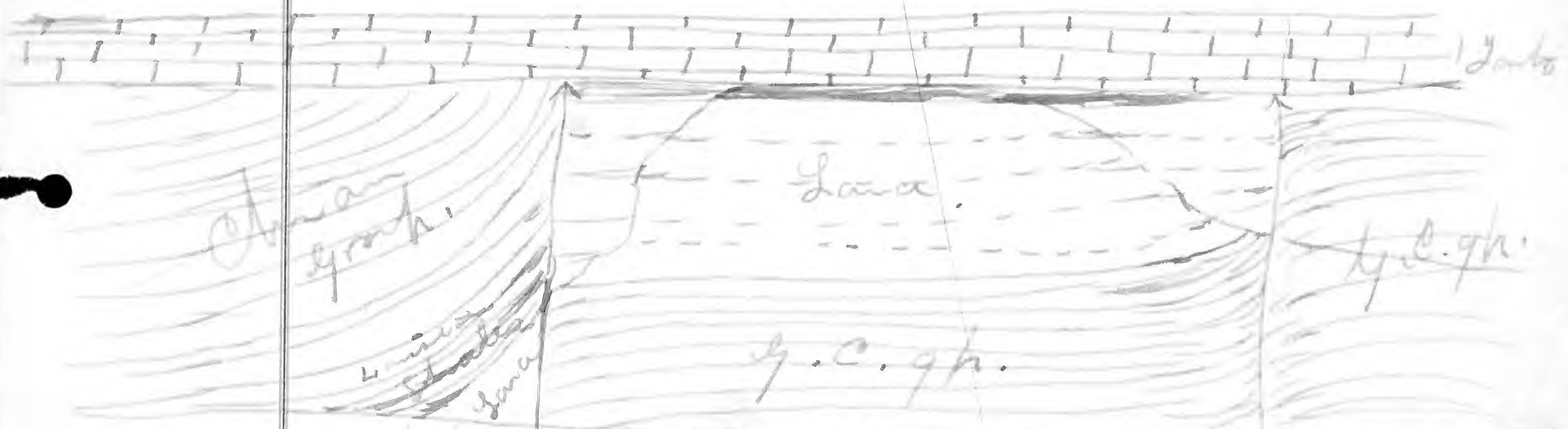
Chuar lava hill holds the same relative position to the Lanto base line south & west of it as it did prior to the deposition displacement made by the Butte fault line on its N.E. side. The Butte fault passing to the N.E. and crossing the river while the Pre-Lanto passes ^{along} ^{west} to the d.v.c. base. It also appears that a branch of the Pre-Lanto passes along the d.v.c. side on the line of the

present Butte fault. An east & west³⁹ section thro' Char Lavea Hill shows the character of the Pretanto fault & that the down throw is to the west on each hand




massive l. on top of lava by 500 feet in undisturbed section

The Tono on the east has been dropped by the Butte fault.

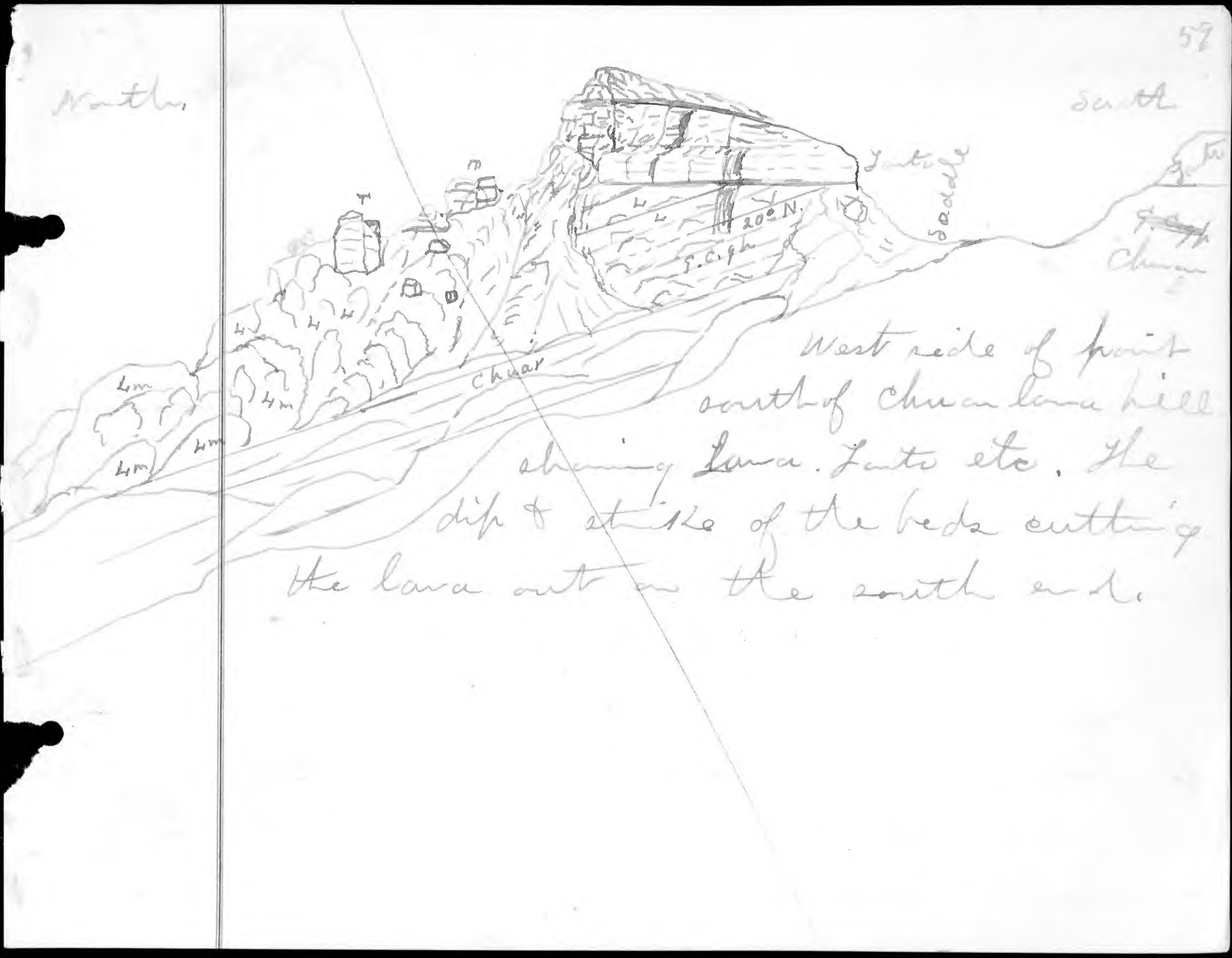


Section before butte fault & subsequent erosion

The drag of the fault on the west side of the
Chico lava hill has bent the lava beds
overlying sandstones & limestone ~~down~~ & as
they became slipped over each other the
friction has ~~changed~~ changed the sd into a
quartzite, polished the surface of the
lava beds so as to make them appear
as tho' they had flowed down the
west side of the hill. Several hundred
feet of strata between the lava & the
Chico group have slipped entirely
out of sight. The same thing occurs
on the ^{west} side of the hill south of Chico
lava hill. The fault here is an oblique
dragging one  slipping & turning the
beds up.

North

South



West side of point
south of Chuan lava hill
showing lava. Lm etc. The
dip & strike of the beds cutting
the lava out on the south end.

1/15/83.

Profile of ridge on south side
of Chaco valley.

2400 feet above
seam.

2400

Foot

Camp at mouth of cañon.

N. Chaco Ridge
To E

Cañon

Upper Chaco

Ridge

Upper Chaco

Cañon

Line of section across divide N. of Chaco

Foot

Chaco

with 20-25° west

top of E.

South divide of
Chaco valley.

View on the divide of the Chaco

1/15/83

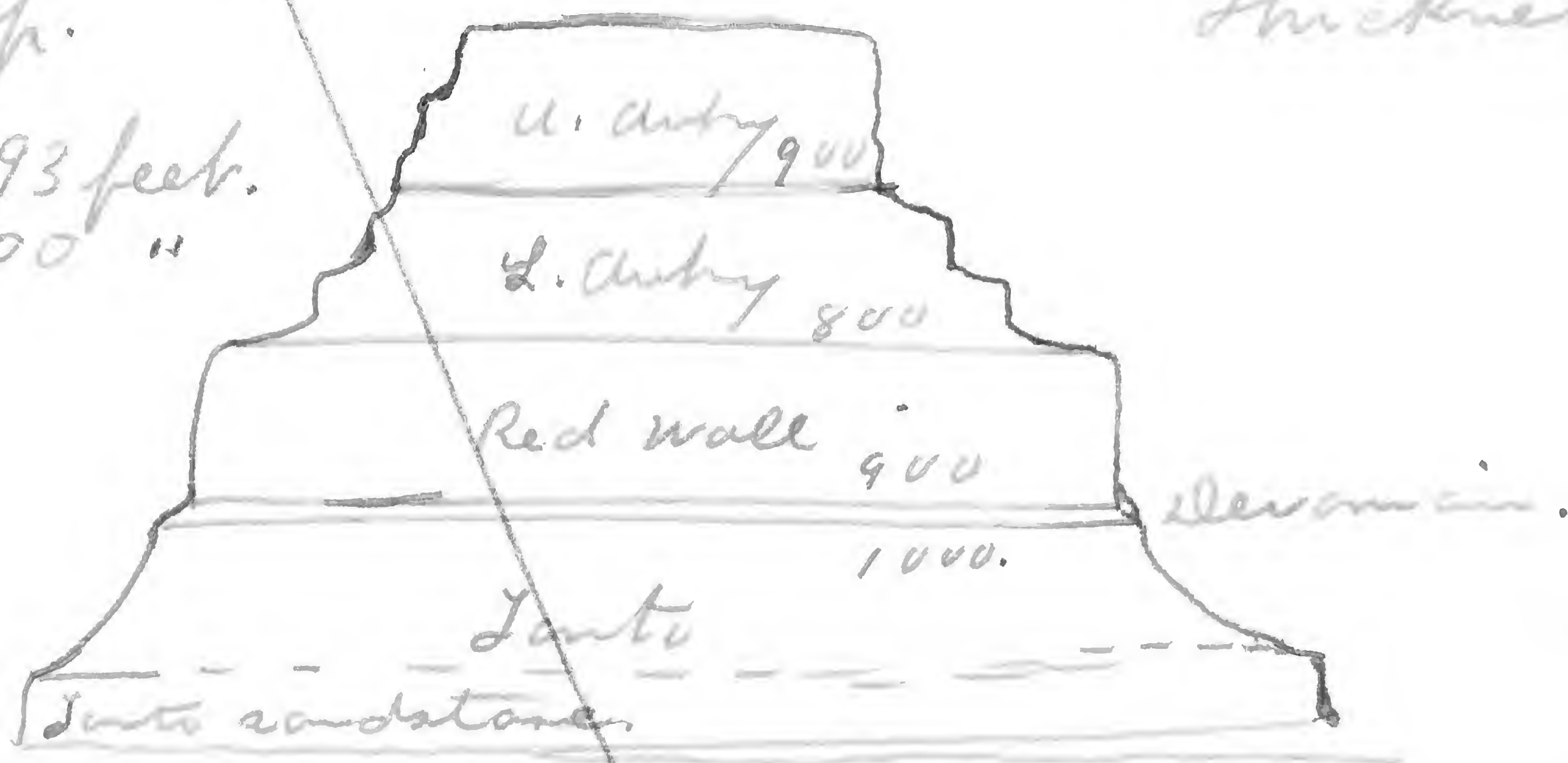
Measured the section of the San And by 61
red sandstone on the butte (Chuar)
opposite the mouth of the little Colorado.

The Red Wall limestone is about the
same thickness as at Muns-Ho-neck 7
At the base of the Arby there are a few
layers of a becciated fine calcarenate
that appears to be made up of bits of the
(a) red quartzite, pebbles, etc.,

~~underlying limestone~~ is an arenaceous
matrix. The lower 250 feet of sandstone
has broken up leaving a terrace on the
summit of the Red Wall l. Several massive
crossbedded layers form a ledge and above
another terrace occurs at the foot of a similar
ledge which is capped by a terrace slope

that extends to the foot of the mesa ⁶²
 crossbedded gray sandstone of the Upper
 Aubrey group. thickness.

Locks level 793 feet.
 Barometer 800 "



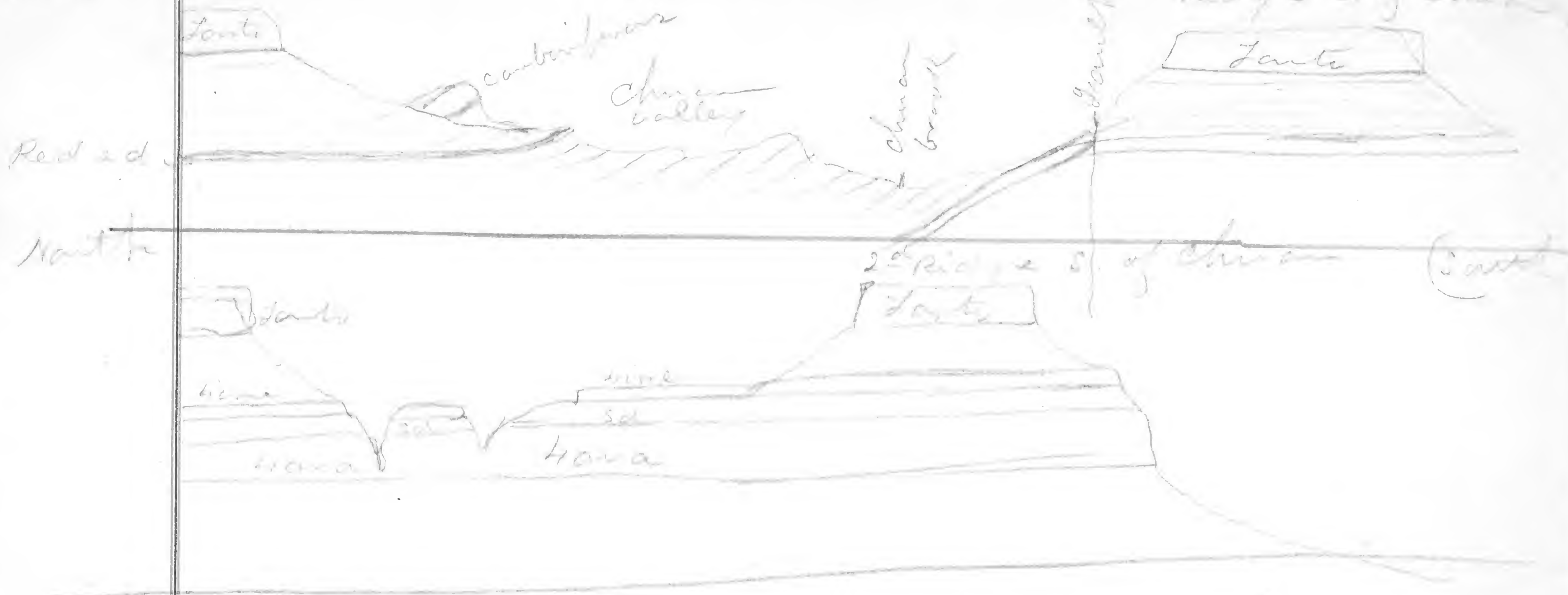
13000

The Upper Aubrey is inaccessible but a cor-
 full measurement in comparison with the
 Red Wall. Taken $\frac{3}{4}$ of a mile distant & at
 the level of the summit of the Lower Aubrey
 gives 900 feet for the upper on the east
 side of the ^{Colorado} River just below the mouth of
 the little Colorado.

1/17/83.

Line of Section

63



Windy cold day. Camp on ridge S. of Chuan valley
2200 feet above the river.

The Devonian ^{Devonian} 1 mi. south of the locality
previously mentioned as on the south side
of Chuan valley is well exposed. To a
slight but distinct non-conformity exists
between it & the base of the Red wall

limestone. In some places a bedded ⁶⁹
limestone conglomerate in a matrix of
greenish clay shale occurs. The layers are
massive & a curious conglom'g of limestone
calcareous sandrock & sandstone. All three
occurring in a layer passing from
sandstone to limestone. There is no
conformity at its base altho' the
line is well defined. An Athyris-like
shell & a Murchisonia were found in the
limestone & scales of Placogonoid fishes
in the sandstone.

Total thickness of Devonian. 125 feet.

1/18/83.

Moved to lower end of canyon of Victoria Temple.

65

1/19/83.

rough log of wind
summit (A)

Section of Grand Canyon Group from where it is marked (granite) crystalline Archean rocks. A belt of quartzitic sandstone of 20 feet in thickness rests on 75 feet of hard fine sand & this forms the ledge above which the Colorado canyons before reaching the Archean. This belt is the cap of great series of fine bedded dark reddish brown sandstones that rise from the river at a dip of 10° . It forms a precipitous cliff. When the quartzitic cap is 1700 feet above the river lighter colored reddish brown or buffish sandstones appear that are similar to those above near the summit.

75
372
415

500

of the group. The 1700 feet of sandstone⁶⁰
was not measured in detail. Only by the
height of the cliff above the river where
the shaly red beds came from beneath.

Going up.

On the quartzitic belt capping the firm
strata a series of irregular bedded
sandstones come in. For 125 feet they are
a friable, shaly in places, ^{light} gray with
reddish spots. Greenish sandy partings.

A massive layer of 10 feet forms a little
ledge & then a curiously quarried & twisted layer
of 15 feet that is overlain by 300 feet of
friable sandstone & sandy & micaceous
shales of a greenish tinge. 125 feet of

greenish chocolate more or less shaly
sandstone & the base of a finer
chocolate colored sandstone is reached.
Total thickness of this stratum 775 ft.
Locks level.

a The next superior series of sandstones form
a cliff broken into by massive bands
by partings of a greenish sandy shale
below & chocolate colored above. The
chocolate color ^{also} deepens towards the
top. The sandstone is fine grained
micaceous, breaking into shaly layers on
exposure. The last 125 feet is more finitely
broken down joining the slope of the
vennids in sandstone above into which
it merges in color.
(Locks level) Total thickness 925 feet

§§§

In one of the east canyons leading down
from Vishnu's Temple a section of the lower
portion of the Vermilion colored of blue
gray laterite gp sands is exposed & the
summit of the ~~tan~~ chocolate beds below.
A ^{layer} dyke has broken up thru & runs in
this mine



Could not come to obtain specimens

1/20/83

clear
cold
freezing
per frozen sh.

Continuation of section Fig. 67

228

69

The chocolate beds grade into the Vermilion colored beds still there is a fairly drawn line between them. In 700 feet the Vermilion beds retain a uniform character massive strata with shaly partings, the massive beds pass up into shale on the slopes. Above 700 feet a greenish gray layer of sand beds ~~beats~~ alternating with the Vermilion beds and keeping the uniform color of the series. Ripple marks & mud cracks mark the upper beds and their shaly character causes them to break down readily, form rounded slopes except where protected in narrow

10.10.2
10.10.2
10.10.2
10.10.2

caused by the overlying lava beds.
(See page 10 note on these beds below
Crown article) Locks level (1732 ft)

1730 ft

Location continued.

1/21/83.

Cold.

Notes taken
in pencil &
copied.

The upper beds of sandstone are
evenly bedded & unmetamorphosed.
Retaining their usual color & hardness
of the strata beneath.

(1) The first stratum of igneous origin
is similar to that of Chuan lavahill
& may be traced with two slight
interruptions to it.

On weathered surfaces it presents a
slope of 25° to 30° crumbles into a
light olive green, coarse sand. Thin

at

306.

1530

200

1700

beds of sandstone similar to that below
occur in several places & one at 125 feet
from the base is quite persistent. The
upper surface is slightly undulating &
nodular. 250. feet

² Reddish brown sandstone hardened
at summit 15 ft.

³ Solid, compact stratum of ^{a dark} greenish
& reddish ~~travertine~~ with a tendency
of the middle portion to a column-
ar structure. The entire stratum
apparently formed of three successive
flows as two division lines occur

1/10/83

48

Chuar lava butte.

All along the south base the redish brown sandy shales & sandstones of the J.C. gr., reach up from the canon bed ~~0 to~~ 50 to 250 feet their upper line of outcrop forming a curve one end resting at the west ^{or upper} end of the canon & the other at the east end near the shore of the Colorado river. The general dip is a little east of north, 5° to 10° . The upper surface of the sandstone is quite uniform not having been eroded irregularly from the lava flow. It presents ~~but slight~~ traces of metamorphism ^{as shown} in the tendency to break into angular fragments & a slight hardening or compaction with the sandstone below. ~~5/~~ The lava appears to have been

greenish

deposited in some other way than a fluid
molten mass & is more like a volcanic sc.
or lava deposited ^{under} water.
~~And~~ the evident lines of bedding in the
lower part are not parallel to the sandstone
supporting this view.

Reds
venetian
like 2

Where it rests directly on the sandstone the rock is more or less porous, small cavities occurring that ~~60 in~~ above are ^{lined} filled with ~~quartz~~ ~~is~~ ~~is~~. Above the mass becomes more compact than

14 a ^{at} reddish to grey & the cavities have a green
lining & enclosing calcite? (2 feet)

Branish
greenish

This passes into a ^{less} compact rock that
weathers into a coarse greenish colored

Level 4/5

and 2/3 Bunch ^{as nodules} of a ~~hard~~ ^{hard} mass
compact rock occur in it (Probably the original
condition of the entire mass.)

Redish
22

These greenish color & general character continues
on up ^{towards} the summit of the stratum on which where
the more uniformly granular structure is
replaced by larger irregularly spheroidal
concretions 1" to 20 mm in diameter filled with quartz
calcite etc. 60 feet from the base a stratum
of redish brown sandy shale 10 feet thick occurs.
This & the fact that traces of bedding are frequent
up thro' to the top adds to the view of the
subaqueous depositing of the stratum. ^(1 1/2) 100
feet from the base a belt of sandstone &
sandy shale 12 to 25 feet rests on the coarse
upper ^{part of the} stratum.

The bed just described with its capping
of sandstone is a marked feature in all

(5)
the exposures of the volcanic rocks along
down the canyon for miles. Recognizing
readily it forms a sloping terrace that is
marked by its smoothness & bottle green
color. Its stratigraphical position is also
strongly defined. 1/11/83. (No. 2)

423

The lower portions of the sandy belt
do not show metamorphism but at & towards
the summit it is changed to a hard almost
quartzitic sandrock & weathers like a quartzite
breaking into angular fragments.

424

125

The floor above this has a stratum of sand
& lava (?) of irregular thickness followed by a
massive bed of fine dark green to a steel
gray greenish-tinted lava. It breaks into

26)

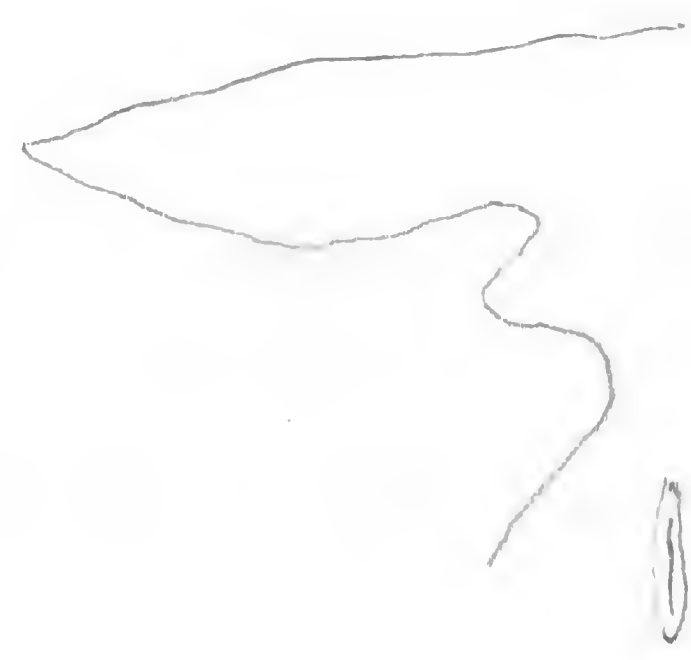
angular fragments & bright up in the flow less than a slaty structure. Near the summit its

27)

macroscopic character changes & little cavities filled in with calcite, quartz etc. occur. When the section crosses the thickness is 100 feet at the east end of the cliff. At the west end 1/2 mile away it is nearly 200 feet. (No 3.)

The line of demarcation between the last mentioned bed & the uppermost stratum is lithologic ^{change of color etc.} but still clearly defined by the erosion leaving a creviced line all along the face of the cliff. The bed above this line is to all appearances a massive lava but when broken looks like a sandstone of a reddish brown color. Higher up it changes

13
28



14

somewhat and being filled with
 minute yellow spots & thin seams. 75
 feet from the base it passes into a reddish
 brown mass with enclosed particles of
 a green color. Thickness 100 feet.

15

The flow above is more uniform in
 character. A reddish brown rock not
 unlike 30 in appearance with larger
 cavities filled with quartz etc,
 Thickness 125 feet.

16

17

This is overlaid by a belt of reddish
 brown fine grained sandstone 5 to 15
 feet thick.

but without sandstone.

25 ft. 125 ft. 25 feet.

175 ft.

72

4 4 feet of a vesicular lava capped
by a thin stratum of sandstone 10"

38 5 In appearance much like that
of 3. (preceding page. Capped by a
stratum of sandstone 2 feet thick 70"

6.

Similar to 5 in lower half but
does not cliff above & the top
slope is of a lighter green color 100"
Capped by sandstone. 1 foot.

7. In appearance like 3 75
+ capped by 5 to 10 feet of sandstone

11/17

8. Breaks into small angular fragments & more of a reddish tinge than the beds beneath. Upper surface a little irregular.

Total

100.
795.

To the north the lava series thickens somewhat as at Chimney lava hill it is over 1000 feet.

The last lava bed is overlaid by reddish brown, ripple marked & mud cracked, fine grained sandstone & shales like those below the lava beds. The section shows the action of the sea between the flows & that

the first was probably ejected (17).
into the water & spread by the
waves or currents. The other beds
appear as tho the lava had spread
evenly on a land surface & then
been covered by a thin deposit
of sand before the next eruption.

Several lava dykes occur not
far away from the lava cliff
but none could be traced directly
to it. The lava in them appears
to be similar to that of the second
stratum. (2).

39
H 0 a
H 1
H 2

Section continued.

1 Reddish brown sandy shales & sandstones. Rippled marked (2.2.198) 200.

2 Partially crossbedded fine grained purplish brown sandstone 50

3 Massive irregular beds of a yellowish brown sandstone (2.2.300) 50

4 Shaly light gray sandstone 25

5 Calcareous sandstone passing into a vesicular irregular limestone.
a Gray, reddish color etc

50-150
375 475

This last stratum of limestone class
 the Grand Cañon gp. as on it rests the
 shales etc., of the Chuar gp. Its upper
 surface here as in Chua valley is
 irregular & nodular & a different
 source of sediment is shown by the
 Chuar beds. With the exception
 of the lava dykes the lava outcrops
 does not appear to have been ac-
 companied by disturbance of the
 strata or any orographical movement,
 the same character of sediment
 follows that precedes it.

~~§ 1~~ ~~Unkan~~ Unkan Valley 77
~~Unkan~~, valley is the ^{most southern} last of the inner valleys
of the Colorado Grand Cañon. At its southern
side end the inner cañon narrows & does not
again widen out until its mouth is reached.
Unlike Nav. Ko-meh + Kwa-gant & Chino valleys
it opens directly on the river & the river
flows thru' it in its central portion
(the Lanto cliff outcropping the valley). It is
almost entirely eroded in the vermilion
colored sds of the L. C. gp. below the Lanto
cliff the strata dipping at low angle to the
northward. The friable sandstones & shales
wear into rounded slopes ridges & hills
& the topography is much like that of inner

Chuan valley. except that on the north the
lava cliffs take the place of the massive
red soil of the latter. One spring ~~exits~~
flows for a half mile in the main cañon.

Above it on the south ^W rises Vishnu's Temple
and on the S.E. S.W & west the beautifully
eroded cliffs of the outer cañon walls.

S.S. Lava beds.

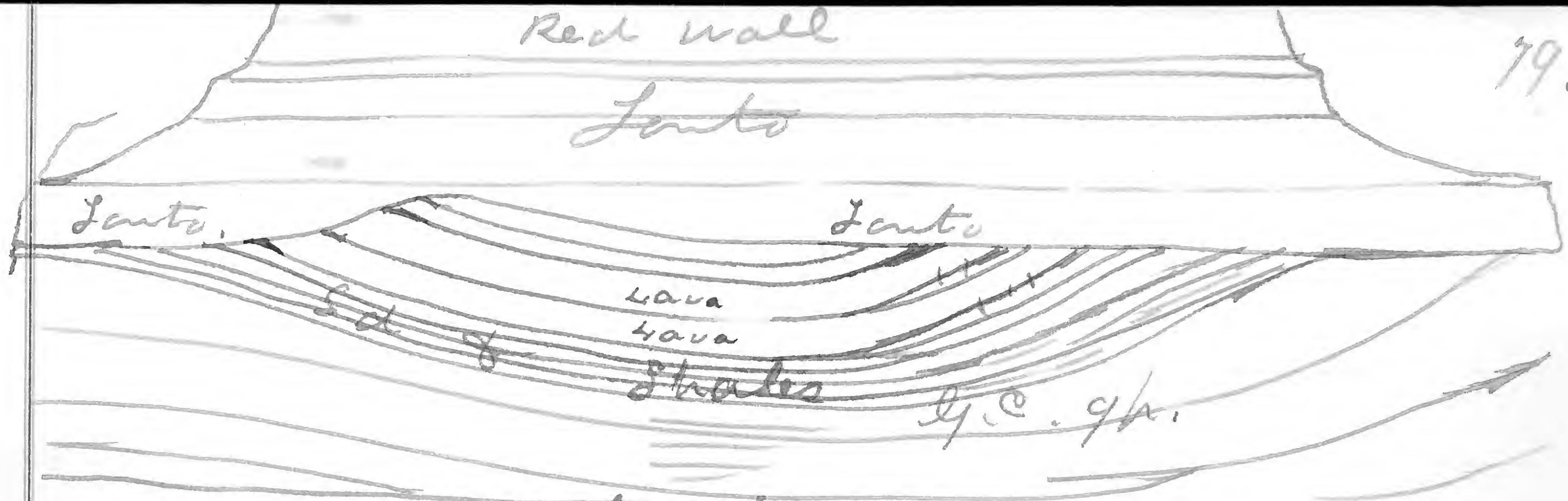
The rise of the strata to the south carries the
lava beds up against the Pre-Lento surface
line & altho' resisting so as to leave a ~~hill~~
on ridge along these ^{lines of} strike of the they are
cut off midway of the valley & do not
appear again to the south. The dykes
that joined them only showing their
main base a few miles further south.

50.11.14

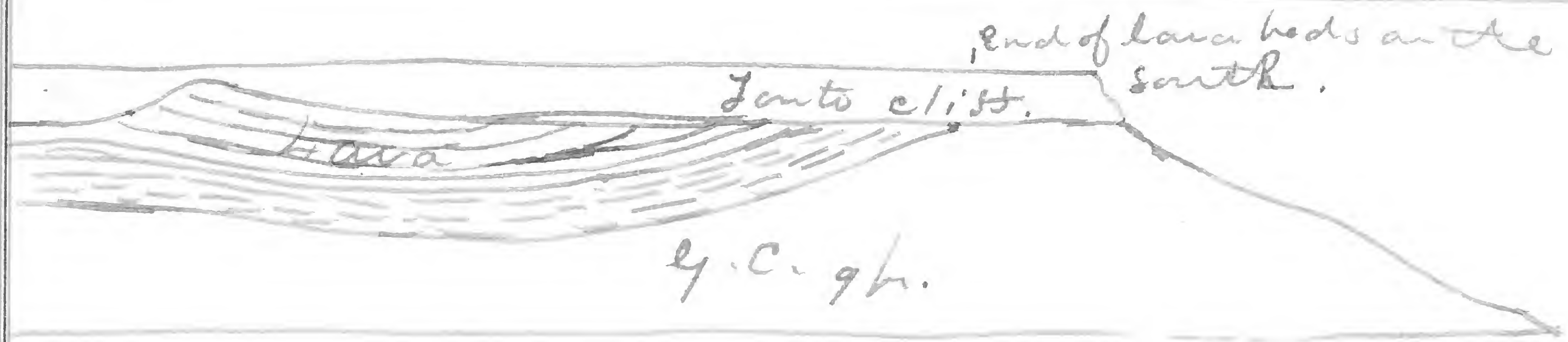
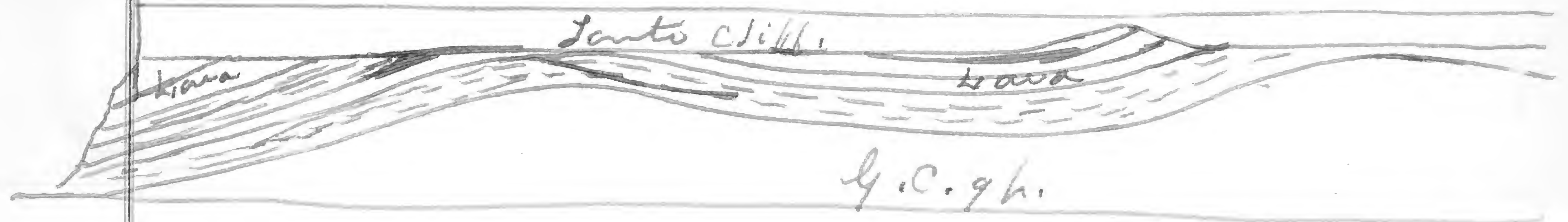


Anticline of Lima exposure
on east side of General Range.

<p>1. In appearance a</p>	<p>much like that of 3.</p>	<p>10"</p>
<p>2. Coldest with</p>	<p>about of sandstone a few</p>	<p>70"</p>
<p>3. Does not differ</p>	<p>in color but as much as</p>	<p>630</p>
<p>4. Like 5.</p>	<p>greenish color</p>	<p>100"</p>



East side of Grand Canyon showing lava beds in synclinal in sandstones of Grand Canyon gh. Fault opposite Chuar valley.



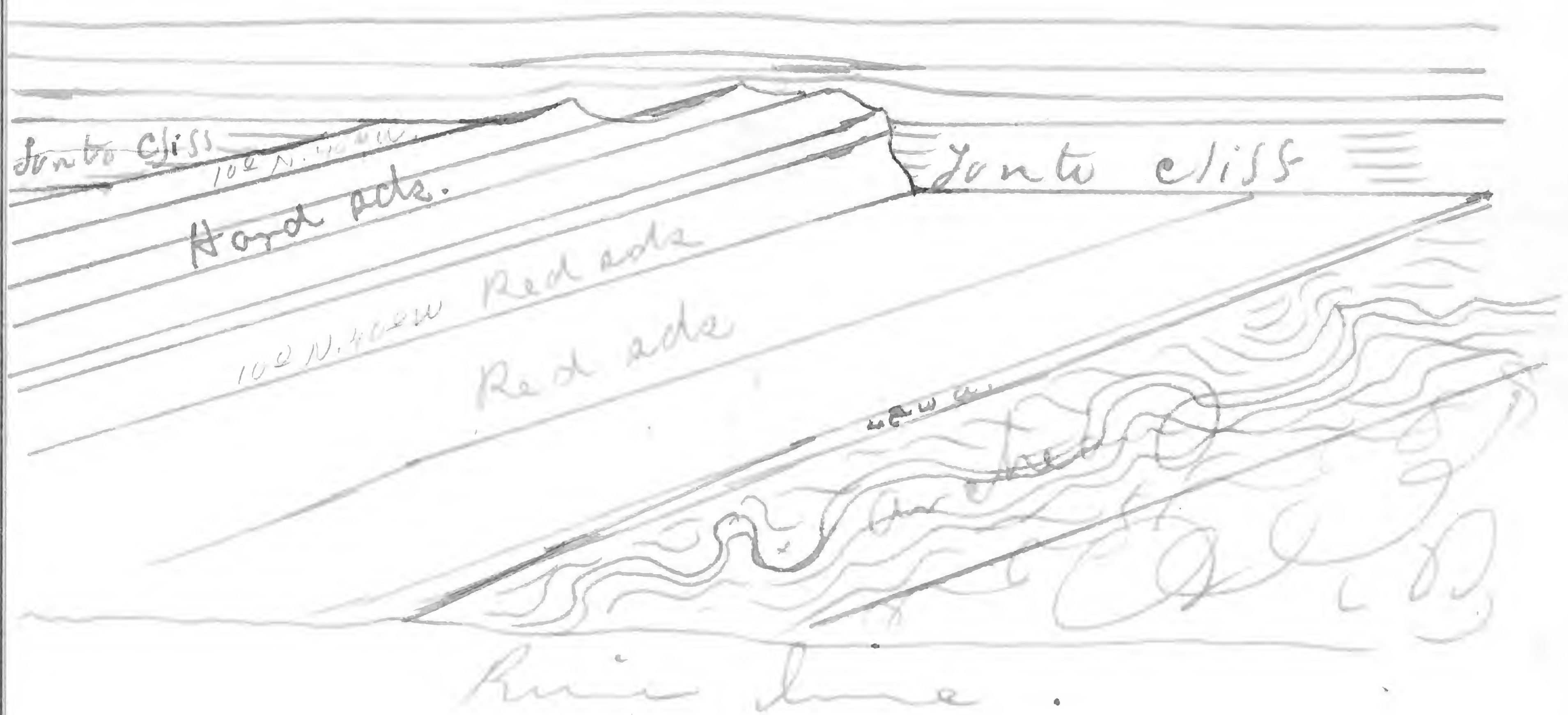
1/22/83. S.S. Followed the cliff of the Lanto sandstone (80)
around to the S.S.E. of Vishnu's Temple. At
the great bend in the ruin & canon
from the S.S.W. course to W.N.W. The
Archean rocks appear from beneath the
evenly bedded vermilion colored sandstones
of the Grand Canon group. The latter
dipping at ^{an} angle of 10° to the N. 40° W.
Between the latter & the Archean a
stratum of lava (Greenstone) occurs.
Estimate of shaly sandstones beneath
massive beds mentioned the 19" 600 to 700 ft.

S.S.

Pre-Lanto surface.

The belt of quartzitic sandstone with
the finer sandstone beneath is prob.

up to the Lento base line by the upward 81
 southern dip it forms a ridge cutting
 up into the Lento as high as 500 feet.
 Thru the massive sandstone cliff &
 into the softer sandstones above.



On the north side of the river obtained
 a specimen of the quartzitic sandstone.


just under the L. - showing the surface polish of the waters that were away the Pre-Lanta land surface.

1/23/83

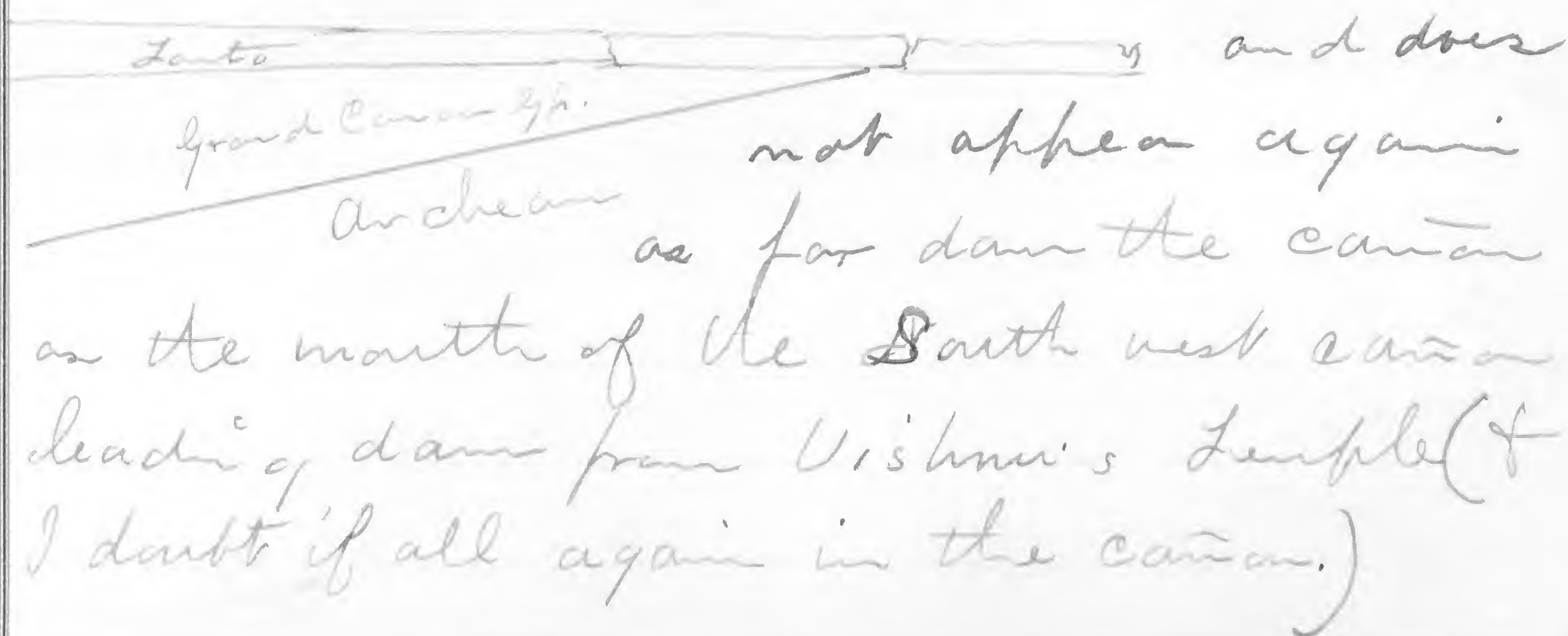
~~Played out. A day of rest.~~

1/24/83

^{SS} Summit of the Archean rocks in the Grand Cañon due south of Vishnu's Temple x

The Archean at this point consists of metamorphosed sedimentary rocks & gneiss (a) mica schists, quartzite, reddish granite in veins etc. Where the section strikes the Archean the surface of the latter dips N. 50° E. ^{10.0} St N. 40° W. (True strike & dip). The strata are vertical to the horizon  & mostly thin layers of quartzitic sandstone with layers

- 1 of micaceous schist & a reddish granite
- 2 rock. The slope of 15% carries this surface rapidly from the river to the base of the Tonto as the course of the canon is nearly E & W. and there the surface is planed off nearly horizontally minor irregularities alone remaining. The Grand canyon gh is entirely wedged out between the Tonto base line & the Archean line.



and does not appear again as far down the canon as the mouth of the South west canon leading down from Vishnu's Temple (I doubt if all again in the canon.)

Section

1) On the Archean surface (Pre-4. C. 4h. surface) ⁸⁴
a band of siliceous conglomerate rests
evidently formed of material worn from the
Archean as pebbles of a character similar
to the underlying rock abound in it. The
conglomerate is firm but breaks
down on exposure to the weather.
30 feet.

2)
Light gray compact shaly limestone with
pinkish tinge along the laminae of bedding.
A little cherty at base on thin ^{hard} sandstone
layers intercalated
26 feet

3.
Dark green lava (Greenstone) in massive
stratum. No change in limestone where it

rests in contact with it. (See Note pg. 86). 85

80 ft.

4. Limestone similar to 2.

14 "

5 Dark redish brown slate

5 "

6 Redish brown sandstone

2 "

7 Cherty redish limestone

10 "

8 Brown sandstone with a bed of
siliceous conglomerate 2 feet.

30 "

9 Limestone with interbedded thin
laminae of quartzitic shale

8 "

10. Redish brown siliceous con-
glomerate 10 feet followed by shaly
brown sds in somewhat massive
layers

80

11 Brown friable shaly sandstone
Ripples and cracks

300

- 11^a Brick red
yellowish red friable shaly sandstone 56.
- 11^b Reddish brown to venicular in friable
shaly sandstone 250.
- 200
750.

The strata of 11. form a sloping
terrace in thin shaly line of exposure,
just along the cañon south of Vishnu's
Temple. (about 1 mile).

12. Massive compact, cliff forming brown. buff
+ purplish brown sandstone. 1200 ft.

Capped by quartzitic band.

Note on No 3. The limestone is a smooth &
soft at the point of contact or below.
The lava bed is constant on the north

side of the canyon from the ruin to where 87
cut out by the Pre-Fault erosion but on the
south side it rises from the ruin & ~~is~~
suddenly disappears as tho' the termination
of the bed. It is not faulted out but
~~simply ends.~~

Several dykes of greenstone were seen
cutting up thro' 11 & 12. but none meas-
urable. 12 was estimated by knowing
the height from the ruin to the
base of the Fault & 11. measured by
the aneroid barometer.

1/25/83

~~Vermilion~~ ^{Unkar} valley. = Un + Kar (88)
give Pah-Uta name for Red. Pau sa - 90?

The view from the southeastern side is one of the most beautiful & impressive of any of any of the grandeur of scenic & geologic interest in the valley portion of the Grand Cañon.

An immense amphitheatre enclosed on all sides but the north by these high, precipitous outer cañon walls & on the north massive buttes rise 3000 feet to ~~stare~~ then ~~rather~~ dropping suddenly 1400 feet to the level of the terrace that holds a level line until breaking in pretty pointed

knolls it is merged into the sweep (89)
of the Plateau margin away to
the northeast. Within these outer
walls ~~(rise from)~~ the Lute terrace
winds in & out, here a bold headland
there notched by a narrow profound
canyon; a symmetrically curved point
around which the contours sweep in
graceful curves ~~to~~ only ^{to} recede around
a broad open cañon and on to a point
that is as sharp & clearly defined as
the leaves of ^{its characteristic plant} the ~~plant~~ that almost
appears to be coextensive with the
terrace. From this terrace line a
gently curved slope broken here & there

by the dark line of outcrop of strata that ⁽⁹⁾ whose outline is that of the terrace contour, rises to the base of the beautifully sculptured & varied points, buttes, headlands, mural ~~walls~~ precipices within the dark forest clad outline of the Plateaus.

Beneath the Lolo terrace another world is entered. The Lolo cliff of 500 feet gives way to slopes in the ^{red} basin-like valley through which the Colorado meanders like a stream of ~~basin~~ ^{smaller} size in some New England valley, less pretentious valley. To the north, however, the river enters thro' the dark green lava cliffs & on the south passes out thro' a narrow canon worn deep

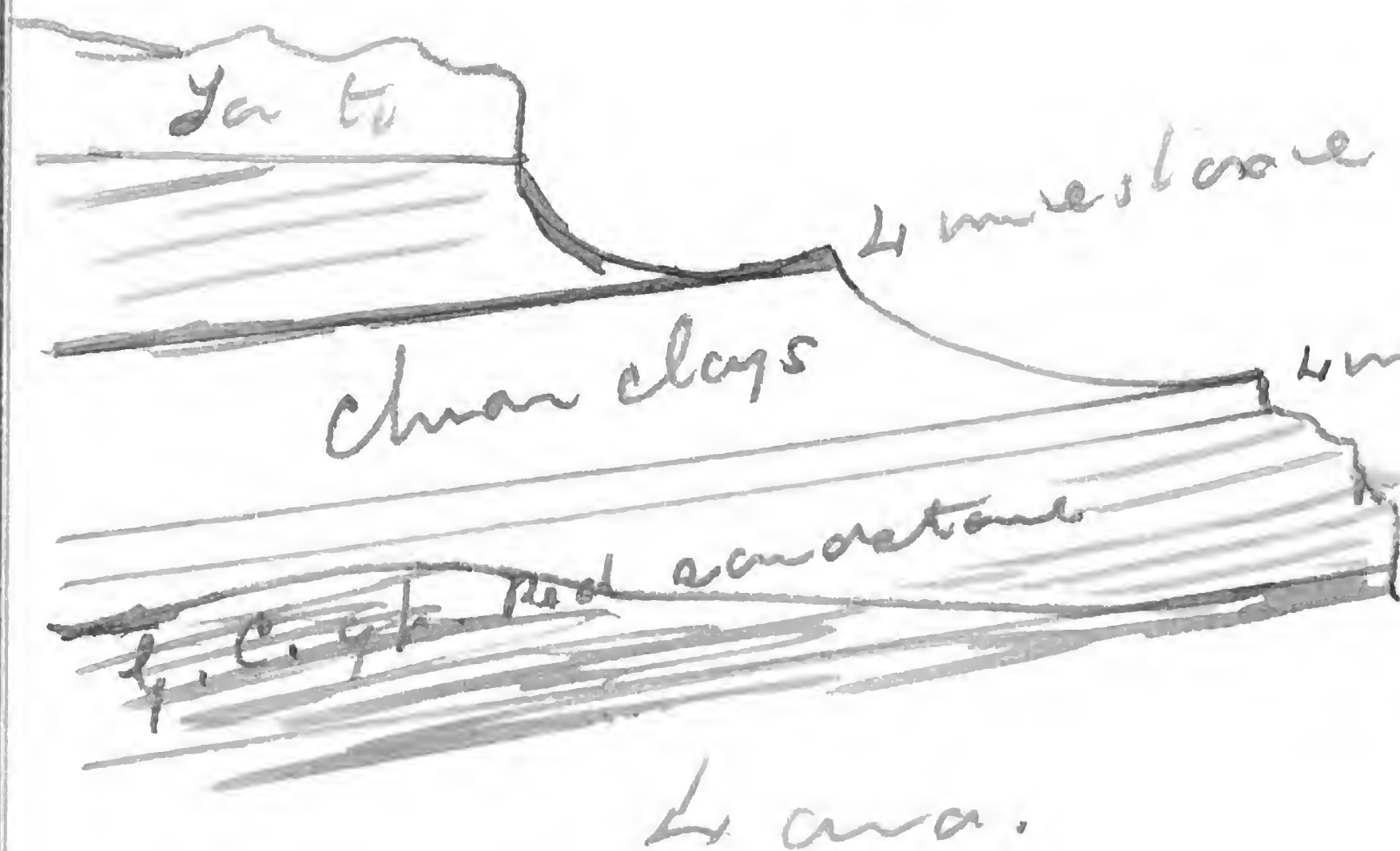
in the dark chocolate ^{colored} sand stones.

(91)

The coloring is more in mass than that of Chuan valley. The rich redish brown of the ~~surrounding~~ ^{ridges} & low cliffs of the inner slopes is toned by the gray bands before reaching the high slopes of dark olive green on the lava beds to the north which give a strong but pleasing contrast to the buff tint of the Lata cliff with its slope of subdued green above. To the south the dark chocolate ^{tint} ~~sandstones~~ replace the green of the lava & here & there a dark green line shows the course of some lava dyke that fed an outflow of Pre-

Chuan date, but last in the series of (92)
Pre-Late times.

Section from Late to main.



The surface of the lava
beds is shown by this
section to have varied
considerably.

Caused by an E-W fault bringing
up a mass of lava against the cliff.

1/27/83.

Southeast branch of the Butte fault on south (S) side of Chuan-lan hill.



Ruin line.
Fault with throw to the north of about 400 feet.

as seen on the east side of the ruin, showing the Karibol fold taking it up at the Red wall limestone the down throw at the Lanta base line about 400 feet. at Chuan-lan hill this increases

to 800 or 1000 feet. On the line of the fault 94
on the east side of Char lava hill. The sand-
stones have been changed to a quartzite
& turned up on edge from beneath the lava.
In some places forming a becciated conglomer-
erate that is impregnated with green carbon-
ate of copper & ??.

a) On the immediate line
of this fault there is more evidence of
metamorphism of the strata that has been
seen from the Ancien up to the summit
of the Poligon series in the Colorado Cana
district. The action causing this metamor-
phism appears to have been Pre-Tertiary.

S.S.
The amygdaloides in the upper portion of
the lava flows & also that of the base of some

of them are coated with a green diasporite 95.
which sometimes fills the entire cavity.
(Angite?) The amygdaloid structure
is owing to the contact of the surface of the
flows with the air or water probably the
latter.

1/28/83

Hevorian on Temple Butte, Grand
Canyon.

The Cambrian terminates below
in a hard compact gray limestone, the
base of the Red Wall limestone at this
point, tho' elsewhere the Hevorian &
upper hard beds of the Lonto unite
with the Cambrian in the Red Wall
cliff.

The Devonian is a little broken up at (96) the summit, for two or three feet in places, and a greenish clay holds the angular fragments.

Dana.

1.

Thin ~~bases~~ of dead colored ~~fine~~ grained l. with a little interbedded purplish sd. 8 ft

2.

Rough calciferous sd in 3 massive layers each having a thin layer of purplish sandstone at the base 22 ft

3

A more calcareous layer of with fossils. Anthis, Atrypa Murchisoni. 4 "

4. Shot at the character of 2. carry the
section down about 30 feet when the
sandstone arenaceous matter predomi-
nates over the calcareous & continues down
to a somewhat arbitrarily drawn base
as the massive Luto layers are
conformable & resemble the Heronian.

46 ft.

Total Heronian 50 feet.

50 feet below the greenish calcareous
beds of the Luto are met with &
Luto fossils over up about 25 feet.
If a strong plane of erosion did not
occur in the Kanab canyon between
the Luto & the Heronian I should
think from this section that one

were passing up thro' a conformable of (98).
unbroken series of beds. The line as drawn
is probably correct as the only well defined
break of bedding occurs there.

S? The uniformity of the plane of erosion
beneath the Gante-Hevorian. Permian
& Shinarump conglomerate along
long lines of clean exposure is surprising
& were it not for the occasional depressions
on cliffs we would have but little
evidence of the existence of such
a plane of erosion.

1/30/83

By ascending the point on the south 94
side of mt. ... an outlet is 1400-
feet above the river - at the summit of the
Lata cliff. A Ch. lava hill 1250-

Base of Lata on south ridge 1400 feet
above camp = 1625 above river. This is
at the east base on the Lata cliff, a
mile to the west the Lata base
is 3 to 400 feet higher.

From the east point of this ridge
a sweeping view is obtained of the
strata below the Lata on the
east side of the river.

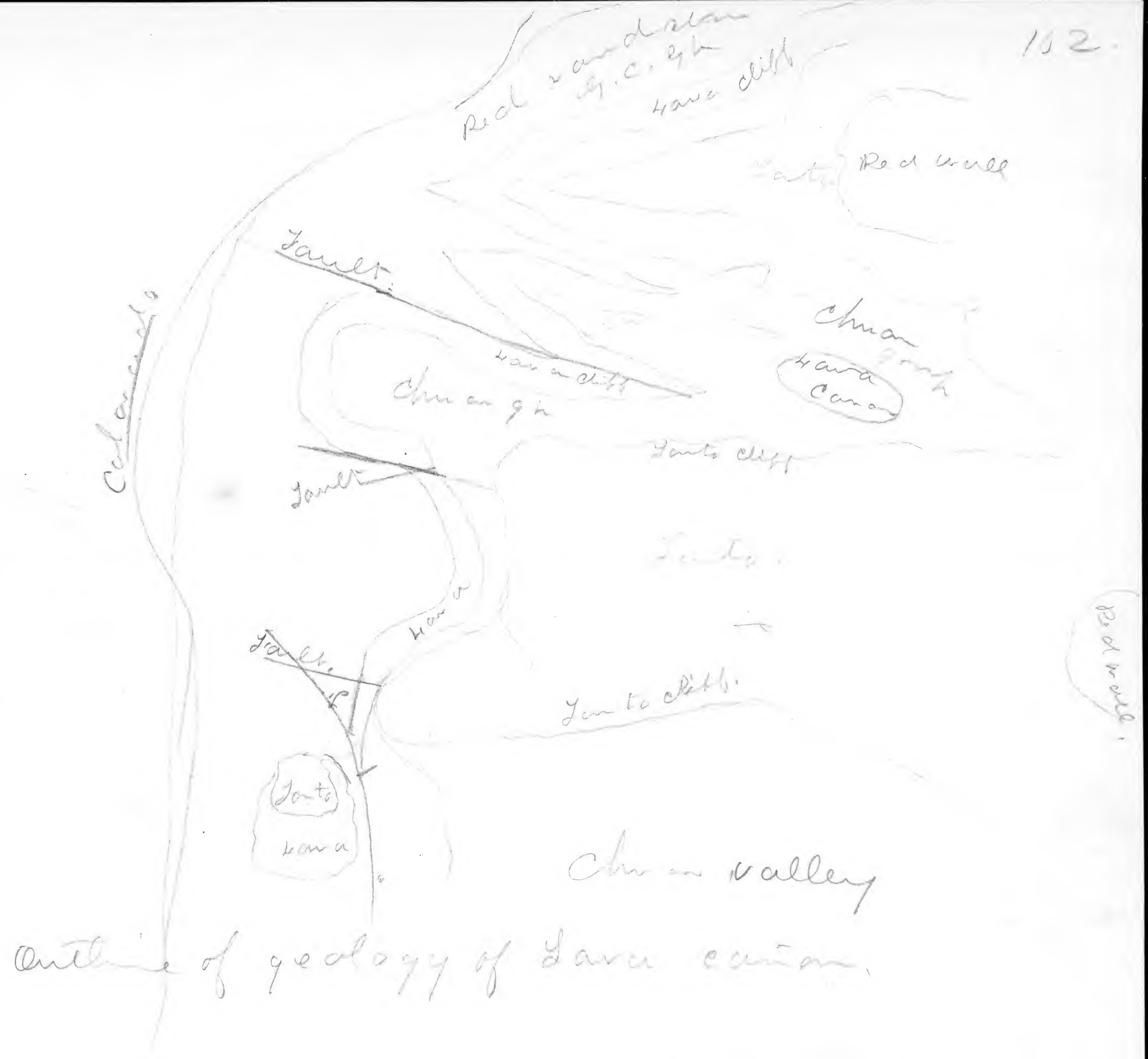
Butte fault.

X Fault not fault. 400 feet downthrown to the south.



The fault at X has not heretofore been determined altho suspected

Its trend is N. 60° E. W. & it crosses the
 summit of beneath the ridge on
 the south of Chuan valley just south
 of the ~~divide~~ saddle at the east end
 of that ridge. This brings the lava beds
 in sight again & at S, the entire section
 of the lava beds is seen with red shales
 at summit as on the west side of the
 summit. The broad undulations of the
 strata cut out & bring in the lava beds
 once more on the south as has already
 been noted. The fault line X was pre-
 sent in greatest thickness but it also shafted a
 450 in the Kaitab mountain. The north side
 going down.

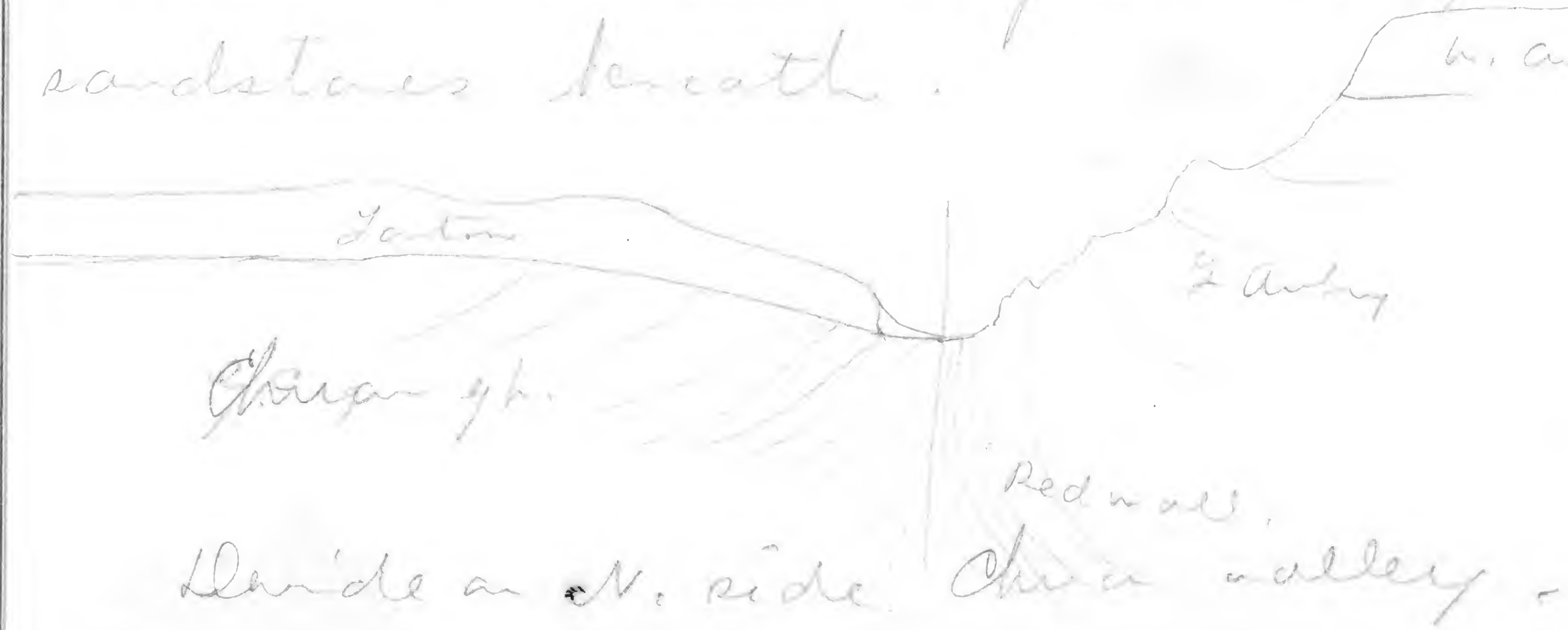


Pre-Lento faulting

All along the Pre-Lento fault the
dip is into the west on s.w. side of
the fault. The two faults near
Lana canyon (see p 102) appear to be
local & could not be traced far.

Lento sandstone.

S S1
Noted red sandstone pebbles that appear
to have been derived from the Grand gray
sandstones beneath.

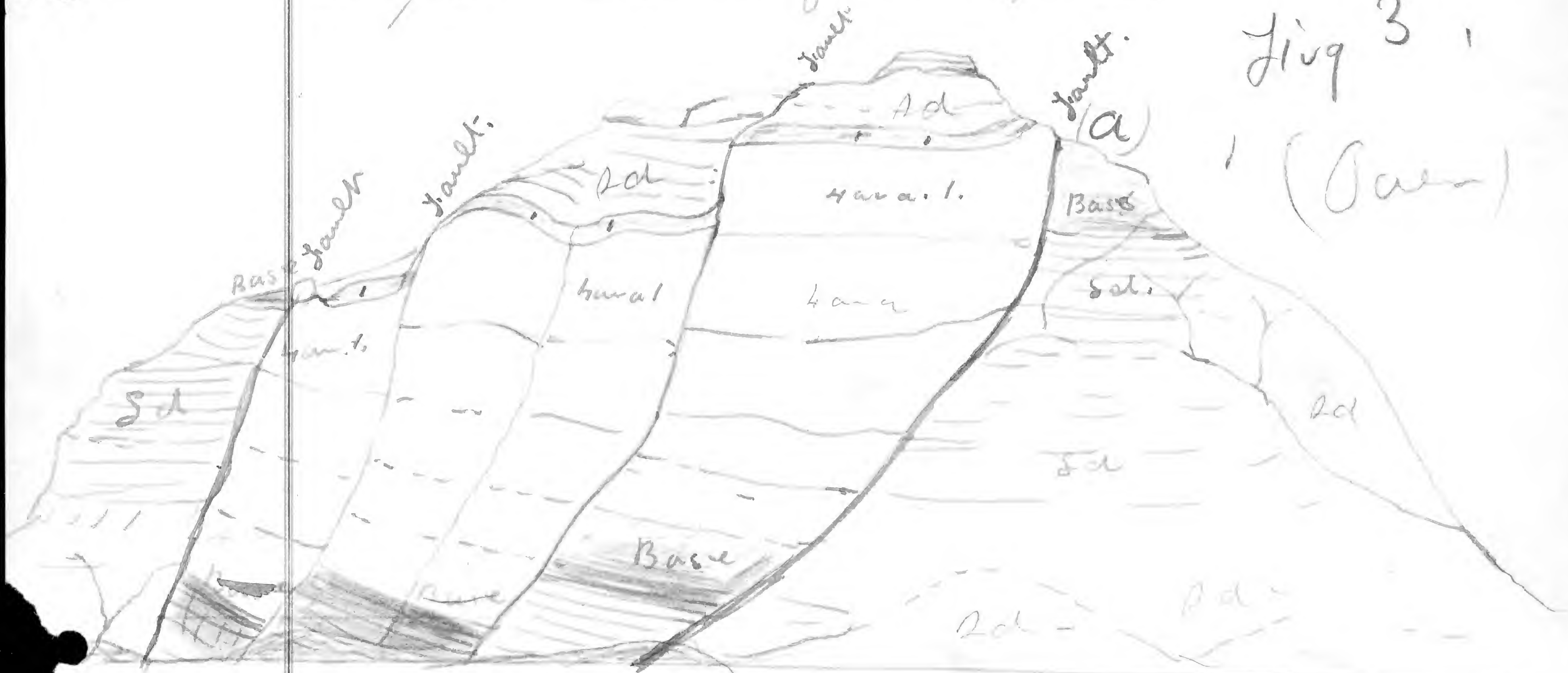


2/1/83

104

a little north of the outlet of ~~Lake~~
 Canyon a double fault lets a block
 of the lava cliff down to the water
 edge. Section of S.E. face.

Fig 3
 (over)



River shown.

The main fault on the north (a) has a dam
 down to the south of about 700 feet. The

Blue = sandstone,

The original lines of bedding of the ¹⁰⁵ sandstones between the lava flows are somewhat bent & twisted but six flows can be distinctly seen on the right (north) side. The block is broken by 3 minor faults before the south fault that dropped the block is reached.

The block faces the great open canon on the east side of the river but the lava there is a mile or more back from the river & has not been dropped by faulting. From this point (south fault) the lava bed continues on around into lava canon. (See outline sketch of lava canon. The

structure of this section: diposes of the
last of Powell's canons or valleys filled
with lava. That of Nun-ko-weak
being faulted up over 5000 feet &
the red sd on top of it is Grand Canon
group & not Lento.

S.S. / Data for section.

Three open or valley-like canons occur between
Huron & Knapgunt valleys, the Lento having
cliff walls like them except on the east where
the Red wall is on Lower Aubrey sd, and
both form a wall thro' which each
has a narrow canon that descends
rapidly to the river. The little fault
line crossing just above the entrance
to these canons. The canon valleys are

at the

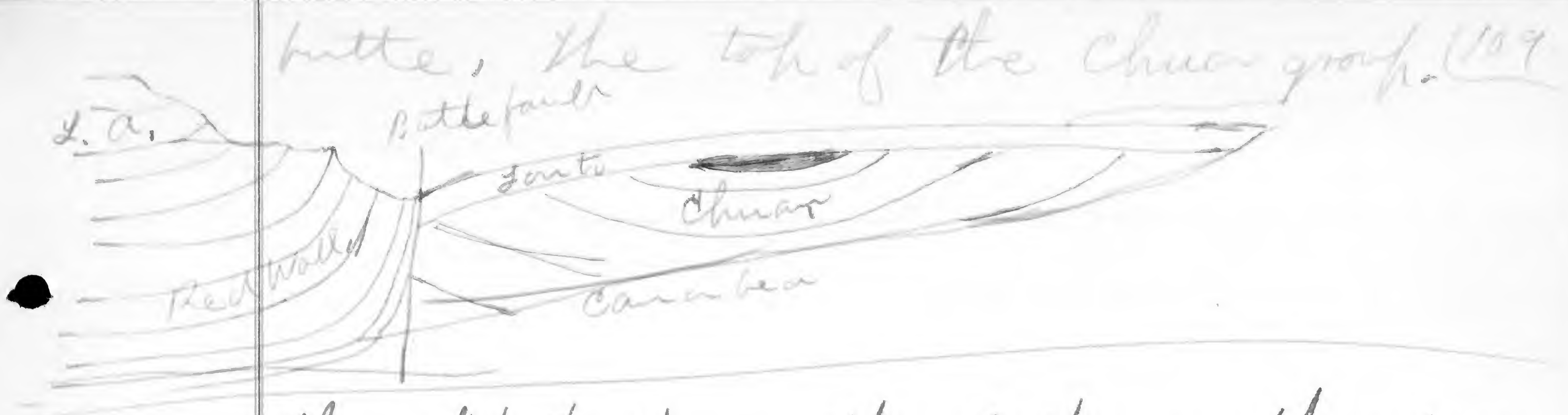
about 700⁺ feet below the ^{flat} ridges of (107)
the Late sandstone that separate
them from each other & Chua &
Kua-gant valleys respectively on the
north & south. The Late cliff

forms the ^{sides & head} ~~rim~~ of each & extends down
3 to 400 feet usually as a cliff, breaking
down at the upper end & near
the little fault line. Below
the Late the clays, sandstones &
limestones of the Chua group are seen
except where masked by the debris
of the Late & Red Wall & the latter
crowning around the head of each

(as seen as sheer cliff. breaking only
as measured by aneroid)

a little at the points jutting out 108
on the Late ridges.

In the most southern of the 3 canyons
the ^{strata of the} Chuar group ~~strata~~ strike $N + S$,
dipping west 45° on the S.E. side, hang
down towards the little fault line. This
dip ~~rapidly lessens~~ to the west &
the beds are horizontal in the
upper portion of the upper canyon.
(See sketch of south side of this canyon
pg.). Passing under the Late ridge
the beds seen on the south side show
in the next canyon ~~as~~ a synclinal
structure and are the $\frac{1}{2}$ same as
those capping Hum-ko-mu-ah

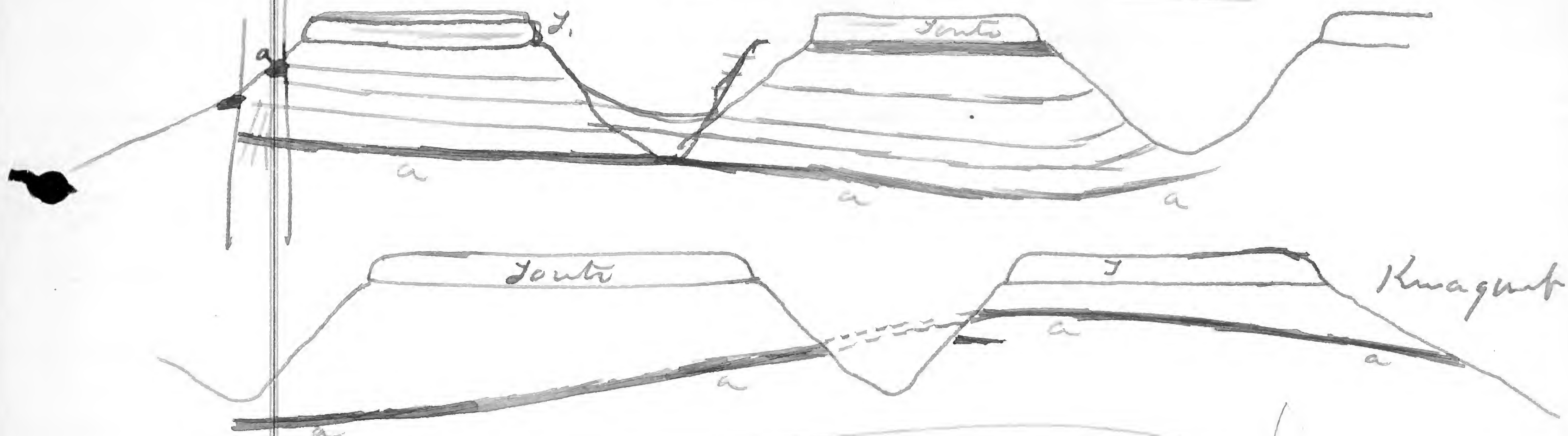


Chuao beds.

The dip to the south of the north edge of these beds carries them up to the ^{Base} ~~base~~ ^{base} line of erosion & they do not appear again except in the synclinal capping Mun-Ko-weap butte. The interval between this & the next or most northerly of the 3 canyons is broad & as debris largely covers the Chuao group in the latter it is difficult to trace the direct section but from the data obtained it appears to be ~~as~~ in the following sketch -

Sketch, Section from Chuan north.

110.



Correct as to distance depth of cañon
etc by map. General plan of structure
shown only.

Readings of Aneroid barometer.

Lower camp Chuan valley,	4000.	2d Cañon North
1st divide North	6250.	estimated to be
" Cañon at bottom. w. fault.	5550.	700 feet deep at
2d divide, North.	6200.	lower end.
3d Cañon " Bottom.	5500.	
Hwagunt divide	6200	
" " Camp	4750.	

2/10/83

The eastern Knäböl small opposite Hane (111)
Rock valley rises from the valley in a curve
of about 10° to 15° & then a level or gently
rising slope of two or three miles leads
up to another mine.

H.R. Valley

at the north end of Pagump-valley
these two folds are united in one
as also at the saddle
at the head of trail Canon.

at the point where the river
turns west thro' the fold the south
cliff shows the same
structure continues south,



The trend of the fold along Horse Rock (112 valley is N & S. but where the two folds unite the direction changes to south 25° to 30° east. It is along this that Pa-gump valley is eroded. Except that the eastern ~~butte~~ of Pa-gump dips rapidly 15° east there is a resemblance in its topography to the ~~inner~~ valleys of the Grand Canyon Nam-Ko-weap, Ku-a-gunt & Chuan. The great butte of the latter = the small one of the former & the drainage channels between them & the saddles heaping Pa-gump on a north and south line also finding their counterpart only on a greater scale.



no fault line, all a fold

LA, B. N 27.

h. 2-3- ✓

" 4. ✓

" 6-10- ✓

" 17-27+ ✓

" 34-42 on wh. chert. after Nov 28- h 34-36 ✓

" 36-38 + continue section one line of h 44-47 ✓

" 41-44- + continued on h 49-52 ✓

" 47-48- Note on Mun. Ho-ve. of Butte- ✓

" 59- Note on tracks etc- ✓

" 61. Upper half a hq. ✓

" 61. Note on fossils ✓

~~60.~~ 61. bottom of page to h 67. ✓

" 64. Note on boulders. ✓

" 64-65, " " Janto- ✓

" 66-71. ✓

" 72. ✓

" 74-76 ✓

" 78-87 ✓

Note Book 7.

Leontomiferous

h 4 , 6-10 , 17-27-

Nov. 30th

h 36.

h 41-44. to line - continue
add note on h 60

on h 49. Dec 4th

49-52

~~add note on 1~~

Bottom of h 61 - (Dec. 9) to top 64

h 66 (Dec 12) to line 68

h 69 (Dec 15) - 71

h 72 - (head started Dec 15)

82.